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ECONOMIC ASPECTS OF BROILER PRODUCTION DENSITY*

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THIS paper explores a long-range planning problem of the broiler industry. Broiler processing costs decrease as plant size is increased, but costs of producing and delivering live birds go up as larger numbers are required at a central location. If a supply area is enlarged, longer hauls between broiler farms and the central location are necessary; if production density is increased in an existing supply area, labor costs for broiler growing may increase. What combination of central processing volume and surrounding production density will yield lowest total unit costs for processed broilers and thus put a supply area as a whole in the best possible competitive position?

The following procedure is used: First, relationships of selected transportation cost items to average one-way lengths of haul between farms and off-farm facilities are estimated; the items considered are chick delivery, feed delivery, visits by fieldmen, live-haul loading, live-haul trucking, and losses of marketable weight during the live haul. Second, the above transportation costs are added to processing costs for various combinations of production density and processing volume, and least-cost combinations are derived. Third, substitution between additional outlays

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The authors are grateful for assistance received during preparation of this paper. Suggestions by J. C. Williamson, Jr., George Tolley, Norris T. Pritchard, A. P. Stemberger, and members of the SM-15 Technical Committee were especially helpful. J. C. Williamson, Jr., developed some theoretical aspects of supply area equilibria in a seminar paper, "Locational Differences in Size of Meat Packing Plants," at North Carolina State College, November, 1957, and is elaborating upon this topic in a paper in preparation, "Concentration and Size of Agricultural Processing Plants Located in Producing Areas."

for transportation and higher payments for broiler-growing labor are examined, and trade practices that encourage development of optimum volume-density combinations are outlined. Finally, implications of scale-density relationships for the competitive positions of regions are pointed out, and a potential limitation upon maximum geographic production density is noted.

Relationships of Transportation Costs to Average Lengths of Haul

Many transportation costs are linear functions of average lengths of hauls

Most of the transportation costs affected by production density are associated with trips from off-farm facilities to farms and back. Loads are carried one way and inter-farm travel is negligible. In such hauling, the unit cost of providing a particular service is composed of handling (loading and unloading), over-the-road travel (fuel and other regular servicing, wear depreciation and repair, and wages of traveling employees), and overhead (taxes, insurance, interest, storage, licenses, etc.).

If commercial volumes are involved, unit handling cost is a constant. Unit over-the-road cost varies directly with the average distance each unit must be hauled. Unit overhead cost depends upon the size of truck fleet required to handle a given volume; as average length of haul is increased, discrete additions must be made to the fleet.[1] If a constant over-the-road speed is maintained, additions to the fleet come at regular intervals as average length of haul is increased.

From the above considerations, the unit cost of providing a particular hauling service is approximately a linear function, with a positive constant term, of the average length of haul. The service of providing visits by fieldmen does not quite fit the pattern described above, but cost of this service is approximately a linear function of average length of haul to broiler farms.

An assumed circular supply area is convenient for budgeting to estimate transportation cost functions

Unit transportation costs as functions of average lengths of haul are valid regardless of shapes of supply areas, distribution of production or specific locations of off-farm facilities. Also, where commercial volumes are involved, economies of size in the transportation services of interest may be disregarded. These two considerations allow an important simplification in estimating the cost functions. Any commercial level of output can be assumed for any hypothetical supply area, and the cost functions

[1] Variations from constant rates of production may also increase the size of truck fleet required to handle a given annual volume.

can then be estimated by budgeting associated activities as average length of haul is varied by changing production density.

The hypothetical supply area used by the authors is isolated and circular; it has all off-farm facilities of interest located at the center, and farm production of broilers is evenly distributed throughout the circle. The authors also assume a steady output rate within each of two seasons and near perfect coordination of all production and marketing activities.

Budgeting to minimize affected costs requires time and space factors for travel within the area. These factors can be easily determined because of the following geometric properties of the assumed supply area:

(1) The relationship among average length of haul, annual volume, and geographic production density is

$$A = \frac{2}{3}\sqrt{\frac{V}{\pi D}}$$

where A is the average length of haul in air miles, V is the annual volume in number of birds, and D is geographic density in birds per square mile per year.[2]

(2) The air distance between adjacent farms is the square root of the land area per broiler farm. This property is helpful in estimating costs of providing visits by fieldmen.

Estimates of production and marketing costs affected by changes in average length of haul are listed in Table 1. Cost levels are budgeted at 10-mile intervals for average lengths of haul varying from 10 to 70 miles. When costs of the separate items are summed across to get total cost for a particular average length of haul, there is an implicit assumption that hatchery, feed supply, live-hauling, and processing firms share a common central location. The costs presented in Table 1 are based on 1959 North Carolina data which are detailed in the notes to the table.

Combinations of Transportation and Processing Costs

The transportation costs of Table 1 could be combined with processing costs under many different assumptions about the locations of other off-

[2] Air distance of average length of haul is related to radius of the hypothetical supply area, R, such that $A = 2/3\ R$. Volume of business in the supply area is related to production density and area, such that

$$V = D\pi R^2 \text{ and } R = \sqrt{\frac{V}{\pi D}}$$

In empirical studies, air distance should be converted to road distance. In the vicinity of Robbins, North Carolina, the average road distance is $1.703 + 1.16\ A$, where A is air distance in miles. The above equation is a regression estimate based upon a 10-percent sample of all broiler farms in this supply area in June 1957.

TABLE 1. COSTS OF FEED DELIVERY, LIVE HAUL, WEIGHT LOSSES, CHICK DELIVERY, AND FIELDMEN AS FUNCTIONS OF AVERAGE LENGTH OF HAUL TO BROILER FARMS

Average length of haul	1 Feed delivery	2 Live haul: truck	3 Live haul: labor	4 Live haul: weight losses	5 Chick delivery	6 Field-men	7 Total of six items	8 Cost of added 10 miles
miles	*dollars per hundredweight live broilers*							
10	.1064	.0713	.1749	.0176	.0121	.1134	.4957	—
20	.1485	.0897	.1927	.0352	.0157	.1170	.5988	.1031
30	.1984	.1169	.2105	.0528	.0193	.1205	.7184	.1196
40	.2507	.1353	.2283	.0704	.0229	.1241	.8317	.1133
50	.3005	.1625	.2461	.0880	.0265	.1496	.9732	.1415
60	.3528	.1897	.2639	.1056	.0340	.1531	1.0991	.1259
70	.4026	.2081	.2817	.1232	.0376	.1567	1.2099	.1108

NOTES ON BASIS OF ESTIMATES AND SOURCES OF DATA

The assumed operations are designed to supply live birds to a single-shift processing plant operated during early morning hours for 250 days annually, 8 hours per day. In 77 summer days the plant processes 4,290 birds per hour. During the remaining 173 work days the plant processes 4,526 birds per hour. During the year the firm handles 8,533,000 birds. A 48-hour week is assumed in chick and feed delivery. Truck overhead costs are based on minimum integral numbers required to do the work within the available time; cost estimates are conventional except that depreciation of transportation equipment is considered to be a function of mileage rather than time. Feed efficiency of 2.5 pounds to 1 pound of live weight and average live weight of 3.25 pounds are assumed.

Costs are based upon steady operation at designed capacity of the processing plant and near-perfect coordination of all activities of the integrated firm. Absolute levels of costs do not represent costs prevailing in the Southeast because the constant term is underestimated. However, the estimated increases in transportation costs with increases in average lengths of hauls should be in line with actual experiences of firms in the Southeast.

The following assumptions underlie the specific cost estimates:

Col. 1. Costs are based on 7-ton auger-unloading bulk feed trucks. Number of trucks required for the assumed firm ranges from 4 at the 10-mile average length of haul to 12 at the 70-mile average length of haul. (J. A. Seagraves, *Bulk Feed Handling Reduces Labor Costs*, A. E. Info. Ser. 68, Dept. of Agr. Econ., N. C. State Coll., Nov. 1958)

Col. 2. Overhead costs are $2,410 per truck per year and variable costs are $0.1165 per mile (not including wages of driver). Overhead costs are based on minimum integral number of trucks required for summer hauling. Trucks are used for two loads per shift when this is possible. The number of trucks required for the assumed firm ranges from 6 at the 10-mile average length of haul to 9 at the 70-mile average length of haul. Ten truckloads of 264 coops each are hauled on each of 77 days in summer, and 8 truckloads of 304 coops each are hauled on each of 173 days for the remainder of the year. Average speed of live-haul trucks is 30 miles per hour. Costs do not include office overhead, communication costs, or salary income to the manager of the trucking firm.

Col. 3. Fourteen birds are hauled in each coop except for 77 summer days when 13 are put in each coop. Birds can be caught and loaded at the rate of 20 coops per man-hour with on-truck cooping and bulk weighing. (W. R. Henry, *On-Truck Crating Reduces Broiler Hauling Costs*, A. E. Info. Ser. 63, Dept. of Agr. Econ., N. C. State Coll., 1958) Truck drivers are assumed to help with loading. Wage rates of $1.00 per hour for loading crew and $1.25 per hour for driver are assumed, and a crew foreman is paid $350 per month. The crew is paid while traveling to and from broiler farms. Crew travel is in 8-passenger station wagons owned by crew members who are paid 8¢ per mile. Average travel rate for crew is 30 miles per hour.

Col. 4. The cost of decreases in chilled eviscerated weight is approximately equal to the value of the pounds of live weight lost at the market price per pound for live birds. Costs are based on live price of 16¢ per pound and live weight losses at the rate of 0.34 percent per hour. Only "over-the-road" costs of weight losses are included. These costs are additions to the lowest weight loss cost attainable with length of haul near zero. (W. R. Henry and Robert Raunikar,

farm facilities relative to the processing plant. In this paper, costs are combined under the assumption that all off-farm facilities doing business with a particular processing plant are located at or near this plant. Combined costs apply to the output of a single plant and are not affected if the other off-farm facilities of interest also service other plants.

"Effective" production density measures density from the point of view of a particular firm

This paper deals with production density in terms of its effect upon unit costs for the outputs of particular firms. Any particular firm may have to share business in the surrounding trade area with competitors offering the same services. Thus, the "effective" production density from the point of view of a particular firm may be much smaller than the geographic production density of its supply area.

The authors propose to define effective production density by reference to the assumed supply area used in estimating transportation cost functions. Suppose the average length of haul and the volume of business are known for a particular firm. There is some hypothetical production density for the reference area that would result in the same average length of haul for the same volume of business. This hypothetical density is the effective density in the trade area of the firm in question. Specifically,

$$D' = \frac{4V}{9\pi A^2}$$

where D' is effective density in birds per square mile per year, A is the average length of haul in air miles, and V is the annual volume of business in number of birds.

Effective production density, as defined above, has three desirable characteristics. First, the two dimensions of average length of haul and volume of business are readily measurable. Second, average length of haul is also an axis for the transportation cost functions of interest. Finally, effective production density can be used for inter-firm and inter-area comparisons without specifying shapes of supply areas, specific locations of

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Weight Losses of Broilers During the Live Haul, A. E. Info. Ser. 69, Dept. of Agr. Econ., N. C. State Coll., Dec. 1958)

Col. 5. Overhead costs are $1,062 per hatchery truck per year and variable costs are $0.1153 per mile (including wages of driver at $1.50 per hour). Overhead costs are based on 2 trucks for 60- and 70-mile average hauls and 1 truck for shorter hauls. Truck capacity is 25,000 chicks; average load is 20,000 chicks. Loading and unloading are assumed to take 2 hours per load.

Col. 6. Fieldmen costs are based on 196 farms evenly distributed in the supply area, weekly visits and record maintenance requiring 1 hour per farm, and average travel speed of 40 miles per hour. Automobiles are provided by fieldmen and they receive 5¢ per mile for travel. Costs are based on 5 fieldmen for 10- to 40-mile average hauls and 6 fieldmen for 50- to 70-mile hauls. Fieldmen are paid salaries of $500 per month.

off-farm facilities, distributions of production, or trade-sharing in supply areas.[3]

Optimum sizes of processing plants are related to effective production densities of their supply areas

Several studies have shown that unit processing costs fall as plant size is increased if plants of various sizes are steadily operated at their designed rates of output.[4] For this paper, cost of processing in model plants of various sizes in New England, as estimated by Rogers and Bardwell, are adjusted to correspond with Southern conditions.[5] A curve is drawn through the adjusted costs to smooth a discontinuity at the 1,200-bird-per-hour capacity and to allow interpolation of estimated costs. The resulting relationship of adjusted costs to plant size is shown in Table 2.

TABLE 2. ESTIMATED COSTS OF PROCESSING BROILERS IN PLANTS OF VARIOUS SIZES, BASED ON 1959 SOUTHERN CONDITIONS

Plant size, birds per hour	600	1200	1800	2400	3600	4800	7200	9600
Processing costs, dollars per 100 live pounds	3.69	3.41	3.21	3.10	2.90	2.79	2.67	2.62

Since transportation costs are combined here under the assumption that other off-farm facilities are located at or near the processing plant, the transportation costs are taken from the "total" column of Table 1 and are approximated as a linear function passing through the costs at the 10-mile and 70-mile length of haul. This function is

$$C = \$0.3769 + \$0.0119\ M$$

where C is cost per 100 pounds of live weight, and M is the average length of haul in miles of road distance.

[3] Average length of haul is often used by businessmen in the broiler industry for inter-firm and inter-area comparisons of production density. Effective density is a better index for such comparisons than average length of haul used alone.

[4] E. L. Baum, J. E. Faris, and H. G. Walkup, *Economies of Scale in the Operation of Fryer Processing Plants*, Tech. Bull. No. 7, Wash. Agr. Expt. Sta., Aug. 1952; J. R. Donald and C. E. Bishop, *Broiler Processing Costs*, A. E. Info. Ser. 59, Dept. of Agr. Econ., N. C. State Coll., June 1957; G. B. Rogers and E. T. Bardwell, *Economies of Scale in Chicken Processing*, Bull. 459, N. H. Agr. Expt. Sta., Apr. 1959.

[5] Plant wages were reduced to correspond to an hourly rate of $1.10 instead of $1.30, management costs were reduced by 20 percent, and total costs were adjusted upward to allow processing of 3.25-pound birds instead of the 3.5-pound average assumed for the New England study. Processing technology, plant organization for various capacities, and prices of nonhuman factors are essentially identical throughout the nation. The adjustments described above account for practically all of the differences in processing costs between the two regions.

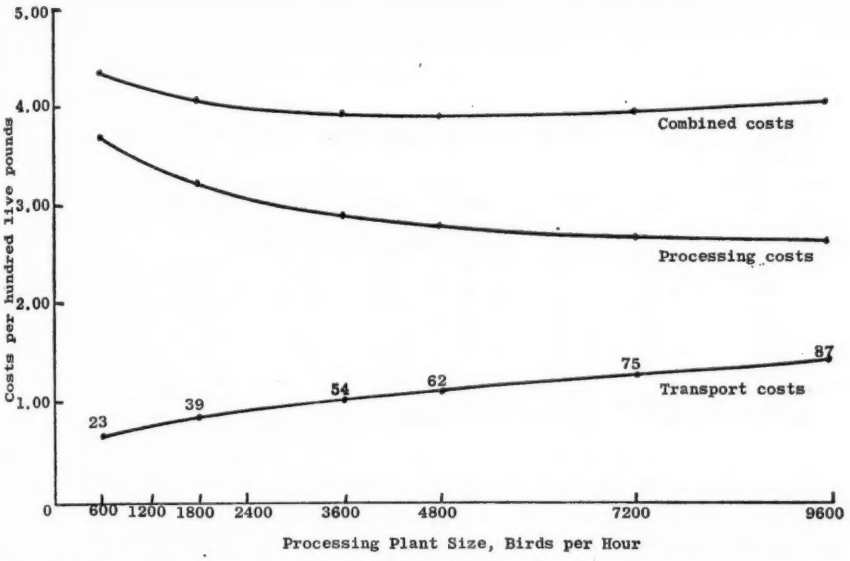

FIG. 1. SELECTED TRANSPORT COSTS, PROCESSING COSTS AND COMBINED COSTS, FOR EFFECTIVE PRODUCTION DENSITY OF 500 BIRDS PER SQUARE MILE PER YEAR, AVERAGE LENGTHS OF HAUL, IN MILES, POSTED ALONG TRANSPORT COST CURVE.

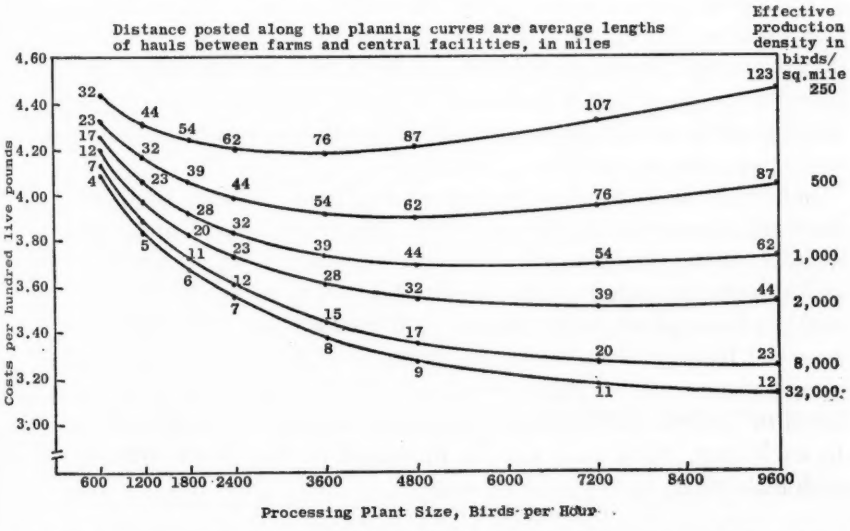

FIG. 2. RELATIONSHIP OF PROCESSING PLANT SIZE TO COMBINED COSTS OF TRANSPORTATION AND PROCESSING FOR DIFFERENT EFFECTIVE PRODUCTION DENSITIES.

TABLE 3. TOTALS OF PROCESSING AND TRANSPORTATION COSTS FOR COMMONLY LOCATED BROILER PRODUCTION AND MARKETING FACILITIES IN SUPPLY AREAS HAVING VARIOUS PRODUCTION DENSITIES

Effective production density in birds per square mile per year	Design capacity, birds per hour, 2,000 hours annually							
	600	1200	1800	2400	3600	4800	7200	9600
	dollars per hundred live pounds							
250	4.45	4.32	4.23	4.22	4.18	4.21	4.32	4.46
500	4.35	4.17	4.05	4.01	3.92	**3.91**	3.95	4.04
1000	4.27	4.06	3.92	3.86	3.74	3.70	**3.69**	3.74
2000	4.21	3.99	3.83	3.75	3.61	3.55	**3.51**	3.53
4000	4.18	3.93	3.76	3.68	3.50	3.44	**3.38**	3.38
8000	4.15	3.90	3.72	3.62	3.45	3.37	3.29	**3.27**
16,000	4.13	3.87	3.69	3.59	3.41	3.31	3.22	3.20
32,000	4.12	3.85	3.66	3.56	3.38	3.28	3.18	3.14

Processing costs per unit for plants of various sizes are depicted by the middle curve of Figure 1. Transportation costs per unit for an area with an effective density of 500 birds per square mile are shown by the lower curve, and the corresponding average lengths of haul are posted at intervals along this curve. The processing cost curve and the transportation cost curve are simply added together to obtain the upper "total" curve. Total cost per unit reaches its lowest point at a plant capacity of 4,800 birds per hour.

Total processing and transportation costs for six levels of effective density are shown in Figure 2. In computing each curve, effective production density is held constant at a selected level and average length of haul is increased as plant size is increased. The air distance to road distance relationship of the Piedmont broiler area of North Carolina is used in computing transportation costs.[6]

Relatively shallow planning curves of Figure 2 mean that, with constant effective density, there is little difference in total unit costs for a wide range of processing plant sizes. For example, with effective density at 250 birds per square mile lowest total unit costs are $4.18 for a 3,600-bird-per-hour plant, while the range from 1,800 to 4,800 birds per hour does not have total unit costs in excess of $4.23. Selected coordinates of planning curves for supply areas having various production densities are listed in Table 3. Boldface type identifies costs for plants of optimum size. In each case, plant sizes can be increased or decreased from optimum with little effect upon total unit costs.

[6] The methods used to construct the planning curves of Figure 2 could be used with other sets of factor costs for other regions, with alternative assumptions about operating practices, and with economies of scale of integrated hatchery and feed mill incorporated.

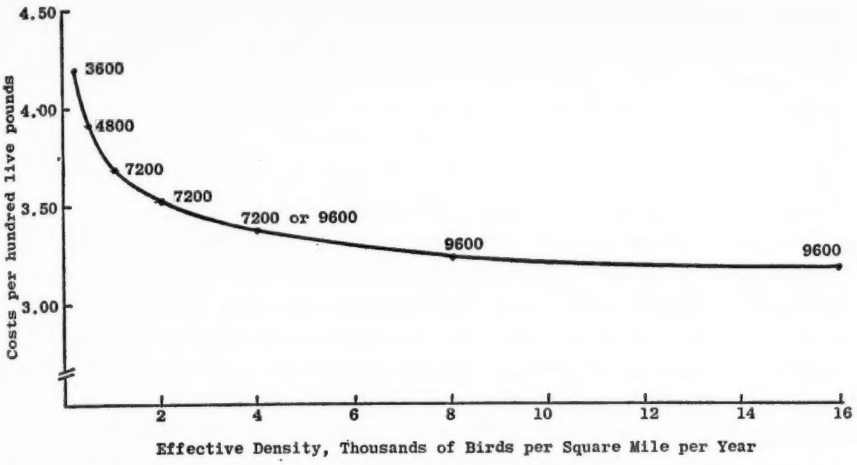

FIG. 3. COMBINED ECONOMIES OF SCALE AND PRODUCTION DENSITY. PROCESSING PLANT CAPACITIES, IN BIRDS PER HOUR, POSTED ALONG CURVE.

Substitution Between Added Outlays for Transportation and Higher Payments for Broiler Growing

If production density is increased, internal economies of larger processing plants can be combined with external economies of greater production density to yield substantial reductions in total processing and transportation costs. Figure 3 shows interrelationships of optimum plant size, effective production density, and total costs. Coordinates of the curve in Figure 3 are the least-cost combinations from Table 3. Minimum total unit costs decrease from $4.18 at an effective density of 250 birds per square mile per year to $3.20 at an effective density of 16,000 birds per square mile per year. This 98-cent saving per hundred live pounds is due to economies of size in processing (28 cents) and reduced transportation costs (70 cents).

The curve in Figure 3 is based on an assumption that production density can be increased without raising production cost. While this assumption may be realistic in the long run for some supply areas, higher payments for broiler growing would be necessary in many others to get increased density.

Optimum production density depends upon the supply curve for broiler growing labor

Costs of obtaining increased production density are mainly increases in labor returns to broiler growers to bid labor away from alternative employments. Payments to growers who own their housing and equipment must, over the long run, cover the costs of these inputs, but these costs

are not dependent upon location of these facilities (except for increases in site values near urban centers, which are not important in the context of this paper). Other inputs used in broiler growing are not provided by growers; prior to addition of hauling costs, supply prices of these inputs are also independent of the locations of broiler growers. Therefore, a rise in production cost as production density is increased would be derived from the supply curve for broiler growing labor.[7]

If a given volume is to be produced in a particular supply area, the optimum production density of this area depends upon its least-cost combination of transportation costs that decrease and labor costs that increase as production density is increased. Optimum combinations of this type cannot be determined without precise information about supply curves for broiler-growing labor. However, information that may be useful in making adjustments toward optimum density can be developed.

Suppose annual volume of production is to be increased by a processing plant and the firms supplying live birds to it. Which is the better strategy —an expansion of the supply area with density constant or an increase in production density with average length of haul constant? The choice depends upon: (a) the amount by which unit transportation cost must be increased under the first alternative, (b) the amount by which unit labor costs could feasibly be increased by using the saving in transportation cost under the second alternative, and (c) the estimated increase in hourly grower labor returns that would bring about the increase in production density which is required under the second alternative.

Assume a circular supply area, centrally located facilities, and evenly distributed production. Transportation costs increase $0.0119 per hundred live pounds for every mile added to average length of haul. Labor inputs for broiler growing are about one-half minute per 3.25 pound bird, or 0.2566 hours per hundred live pounds. A saving of one mile in the average length of haul would cover the cost of a wage increase of $0.0119/0.2566, or $0.0464 per hour.

Now, note two characteristics that apply exactly to the assumed broiler supply area and approximately to typical operating conditions: (a) if average length of haul is held constant, any percentage increase in volume must be accompanied by an equal percentage increase in production

[7] Three other factors that might set limits to production density were considered: (1) In the short run, capital for construction of new broiler housing may be limiting, but broiler businessmen who are interested in maximizing profits over the long run can overcome this limitation; (2) Increased likelihood of disease spreading from house to house in broiler areas could discourage increases in production density, but contagion-reducing practices that should be used even when production is widely scattered would eliminate this limitation; (3) A possible reduction in value of broiler litter for crop fertilization as broiler growing becomes more centralized is discussed in another section of this paper.

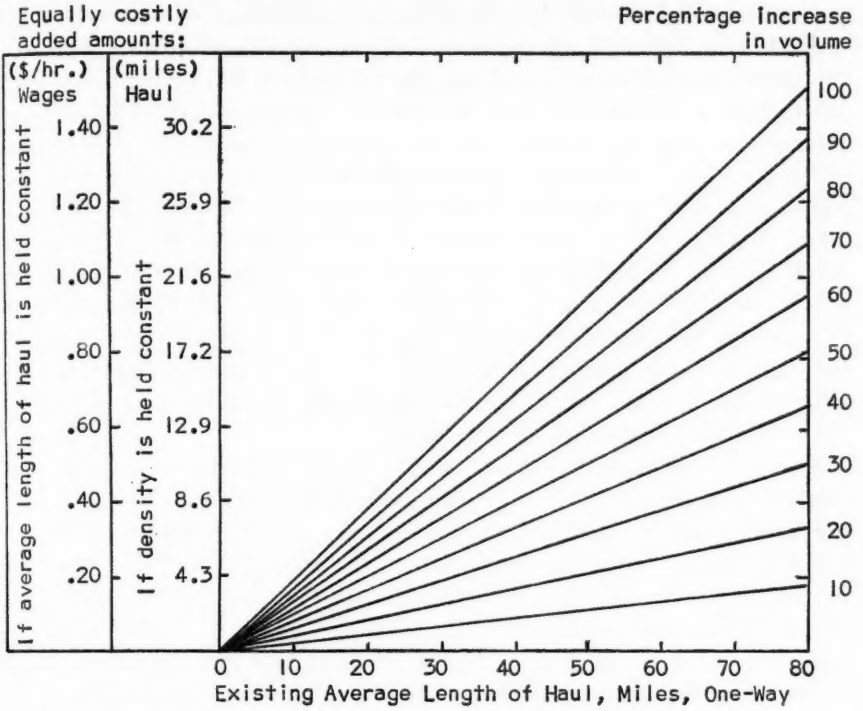

FIG. 4. COMPARISONS OF INCREASES IN HOURLY GROWER WAGES WITH EQUALLY COSTLY ALTERNATIVE INCREASES IN AVERAGE LENGTH OF HAUL WHEN BROILER SERVICING AND PROCESSING VOLUME IS TO BE INCREASED BY VARIOUS PERCENTAGES.

density; (b) any increase in average length of haul resulting from holding density constant as volume increases is determined by the percentage increase in volume and the average length of haul before the increase.[8]

Based upon the conditions of the two paragraphs above, Figure 4 shows equally costly increases in hourly grower labor returns and increases in average lengths of haul when annual volume is to be increased by various

[8] Starting with

$$D' = \frac{4V}{9\pi A^2}$$

as defined above, to increase V to bV while D' remains constant, A^2 must be increased to bA^2; i.e., A must be increased to $A\sqrt{b}$, or by an amount $\Delta A = A(\sqrt{b} - 1)$. If road mileage, R, were proportional to air mileage, A, then R would increase by the corresponding amount $\Delta R = R(\sqrt{b} - 1)$. Where R is a linear function of A containing a constant term, however, this relationship is only approximate. In our case, $R = 1.703 + 1.16A$; i.e., $(R - 1.703) = 1.16A$. The corrected increase in road mileage is therefore

$$\Delta R = (R - 1.703)\ (\sqrt{b} - 1)$$

Therefore the increase in road mileage, ΔR, is a linear function of the original mileage, R, with a small negative constant term.

percentages and average lengths of haul have various present values. In order to use Figure 4, choose one of the slanting lines corresponding to the percentage increase in volume—for example, a 100 percent increase. Next, draw a vertical line from the present average length of haul to an intersection with the slanting line—for example, from the 50-mile length of haul. Project a horizontal line from the intersection to the scales on the left margin and read the two values found there—in the example, 20.7 and $0.96. Hourly grower labor returns could be increased by as much as $0.96 without exceeding the alternative increase in unit transportation cost as average length of haul is increased by 20.7 miles. If the required 100 percent increase in production density can be achieved with a smaller increase in hourly grower labor return, it is the better choice of the two alternatives. In many cases, increases in density would be more profitable than increases in sizes of supply areas.

Even if no increase in volume is anticipated, a broiler production and marketing organization may be able to reduce total costs by increasing production density near the operating center. Average length of haul is reduced approximately in proportion to the square root of the increase in geographic density of production coming to the plant. If production density is doubled, average length of haul is reduced to approximately $\sqrt{½}$, or 0.707, times its former length. With density quadrupled, average length of haul is approximately $\sqrt{¼}$, or 0.5, times its former length.

Trade practices may need changing if broiler areas are to take advantage of economies of density

An integrated production and marketing organization stands to capture all savings resulting from decreased average length of haul. If such an organization grows broilers in its own housing with hired labor, it can locate broiler housing and equipment close to the operating center. No institutional factors restrict exploitation of economies of density.

However, an obstacle may exist where an integrated broiler producing and processing firm offers typical contracts for broiler growing in grower-owned housing. An ordinary "incentive" contract provides no greater incentive to nearby than to distant growers. Such a firm might find it highly profitable to establish contracts with mileage differentials that would partially reflect out-haul and in-haul costs associated with mileage. The average level of payment for broiler growing might be kept unchanged. Over time, the mileage differentials might be adjusted to give nearby growers the full amounts of savings in transportation costs. Gradual adjustment of the mileage differential would provide time for nearby growers to increase their capacities and for remote growers to depreciate buildings and equipment. As the effective density of the supply area increased, the inte-

grated firm would benefit because the average cost per pound to obtain the desired volume would be gradually lowered. Such a mileage differential should be built into contracts in such a way that other variable payment provisions, such as incentives for efficient feed conversion, would not be affected.[9]

Obstacles are more difficult to overcome where hatchery, feed supply, broiler growing, live-haul, and processing firms are related by contracts, informal agreements, or open market trading. Each firm stands to gain to some extent if production density is increased, but none can capture all the gains. In any event, these gains come about only if nearby growers are given incentives to increase production. In this type of producing and marketing organization, consideration should be given to the following arrangements: (1) use by the hatchery of mileage charges in pricing baby chicks; (2) use by haulers of mileage charges in rates for live hauling; (3) use by feed dealers of mileage differential contracts with growers; (4) payments by processors for live birds on a delivered and plant-weight basis. Such arrangements would accumulate savings from nearby growing in returns to feed dealers. The feed dealers could then reflect these savings in contracts with growers. Over time, the supply areas would become more compact, hourly grower-labor returns would increase, and total costs per pound of processed broilers would decrease.

Comparison of Regional Opportunities to Reduce Costs by Increasing Effective Densities

Geographic production densities vary widely when specialized broiler-producing regions are compared. Areas with greatest geographic densities are generally believed to have resulting competitive advantages. However, it is effective production densities affecting unit costs building up at particular processing plants, not geographic production densities of regions, that should be compared.

Effective production densities are not closely correlated with geographic densities

The authors queried selected broiler processors by mail during April of 1959. Each processor was asked to provide his weekly rate of processing, in number of broilers, and the average length of live hauls in the week prior to receipt of the questionnaire. From this information the effective production density in the supply area of each plant was estimated. Results of the survey are shown in Table 4.

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[9] Differentials based on zoning might be more practical than differentials based on mileage. They would lead to similar ultimate results: Increased production density, shorter hauls, and lower total production costs.

The long hauls of the North Carolina Piedmont stand in sharp contrast to those of the other four regions. Average total cost of live hauling (truck, labor, and weight losses) is estimated to be about one-eighth cent per pound higher in Central North Carolina than in the other regions. For this comparison, labor wages, truck costs, and broiler prices are standardized at North Carolina levels.

In the four regions having greater production densities than North Carolina, effective densities range from 3,000 to 4,500 birds per square mile per year. Compared among themselves, none of the four regions appears to have a significant competitive advantage in effective density. It may be noted that there are wide variations in effective densities within these regions, and that all could have substantial reductions in transportation costs if effective density were increased to levels approaching 16,000

TABLE 4. ESTIMATES OF EFFECTIVE BROILER PRODUCTION DENSITIES IN THE SUPPLY AREAS OF PROCESSING PLANTS, APRIL, 1959

Region	Number of plants providing data	Average length of live haul, mean for region (miles)	Effective density (birds/sq. mile/year)	
			Range	Mean
Maine	4	27.5	2143–5270	3695
Delmarva	5	23.5	2380–6120	4515
Central North Carolina	12	47.2	151–8143	1382
North Georgia	4	28.8	1719–4619	2984
N. W. Arkansas	5	28.0	491–8360	4141

birds per square mile per year. Efforts to increase effective densities are expected to be accelerated in all regions as the potential gains are appraised by individual firms.

Geographic production densities may eventually be limited by opportunities to use old broiler litter in crop fertilization

Broiler manure is a valuable by-product if it can be used in fertilizing crops located near the place where the broilers are grown.[10] Because the marginal productivity of fertilizer does drop toward zero as higher levels are applied, there are definite limits to the amounts that can be used profitably. Because litter is very bulky in relationship to its fertilizer value, it

[10] If litter can be used as a substitute for commercial fertilizer then the cost of fertilizer places an upper limit on its value.

Applied on a field, the litter from 1000 birds might be worth as much as $30. This assumes: an analysis of 1.6 percent nitrogen, phosphate and potash (see Parker, M. B., and Perkins, H. F., "Manure from Georgia Broilers Valued at $12 Million a Year," *Broiler Growing*, Sept., 1957, pp. 14-15), an output of three tons of litter per 1000 broilers (based on weight records kept by one North Carolina grower), and a cost of $50 per ton for 8-8-8 fertilizer.

TABLE 5. "POTENTIAL" BROILER PRODUCTION DENSITY IN SELECTED REGIONS, AS LIMITED BY USE OF BROILER LITTER FOR FERTILIZING CROPLAND IN USE

Region*	Cropland in use, acres per square mile, 1954**	"Potential" broilers per square mile per year	Square miles in the region	"Potential" total production, millions of birds per year	Estimated 1958 production, millions of birds
Maine[a]	36.8	36,800	9,317	343	37
Connecticut[b]	88.2	88,200	1,604	142	25
Delmarva[c]	231.6	231,600	3,335	772	173
Pennsylvania[d]	317.3	317,300	3,095	982	16
Virginia-W.Va.[e]	109.9	109,900	4,435	487	58
North Carolina[f]	87.8	87,800	2,668	234	32[l]
Georgia[g]	91.9	91,900	4,823	443	186
Alabama[h]	117.0	117,000	3,874	453	54
Mississippi[i]	117.0	117,000	3,230	378	57
Arkansas[j]	158.4	158,400	3,855	611	87
Texas[k]	111.2	111,200	4,170	464	35

* Specialized regions consisting of counties as listed below.
** Includes cropland harvested, cropland used only for pasture, and improved other pasture, as listed in the 1954 Census of Agriculture.
[a] Kennebec, Knox, Penobscot, Somerset, Waldo.
[b] Windham, New London, Tolland.
[c] Kent, Sussex, Caroline, Talbot, Wicomico, Somerset, Worcester.
[d] Adams, Berks, Chester, Lancaster.
[e] Rockingham, Shenandoah, Page, Augusta, Pendleton (W.Va.), Grant (W.Va.), Hardy (W.Va.).
[f] Chatham, Moore, Montgomery, Randolph.
[g] Banks, Barrow, Cherokee, Cobb, Dawson, Forsyth, Fulton, Gilmer, Habersham, Hart, Hall, Jackson, Lumpkin, Stephens, White, Aiken (S.C.).
[h] Cullman, Jefferson, Marshall, Walker, Winston.
[i] Leake, Rankin, Scott, Simpson, Smith.
[j] Benton, Carroll, Madison, Washington, McDonald (Mo.)
[k] Nacogdoches, Panalo, Rusk, Sabine, Shelby.
[l] Estimated from a May 1958 survey of broiler feed supply firms in these 4 counties.

is unprofitable to haul it long distances to cropland outside a supply area. Hence, if the available litter per acre of cropland in a particular supply area should exceed the level of profitable application, the value of this by-product would be expected to drop sharply.[11] In the absence of satisfactory estimates of the productivity of broiler litter on different crops, the authors assume that it is profitable, on the average, to make annual applications of litter from 1000 birds on each acre of nearby cropland. This rate is believed to be in line with North Carolina farm practices in broiler areas.

Using the above estimate, the authors computed "potential" geographic

[11] This may not be true if cheaper methods of hauling litter, or if new uses for it and methods of processing and marketing it are found. Dehydrated poultry manure is widely sold as a garden fertilizer. However, the market for this product is quite limited.

production densities for selected broiler producing regions. "Potential" densities are based on an assumption that broiler litter must be used on cropland within the regions and are computed by multiplying cropland per square mile by 1000. Estimates of cropland per square mile, total "potential" production, and actual production are listed in Table 5. Estimates of actual 1958 production are based on the assumption that each county produced the same proportion of total state production in 1958 as it did in 1954. Broiler production is overestimated in the cases of regions in the southern states when this procedure is used. Even so, "potential" production densities appear to be considerably greater than actual 1958 densities. To generalize, opportunities for profitable uses of broiler litter are not now limiting geographic production density although they eventually may do so.

Conclusions

Economic aspects of broiler production density were investigated by generating costs for assumed operations of varying size and areas of varying production density. Input-output coefficients and factor prices are fairly typical of conditions in the southeastern United States. The conclusions of this investigation are as follows:

1. Costs of transporting feed, chicks, and production supervisors to broiler farms and of hauling live birds back to processing plants are estimated to increase at a rate of 1.19 cents per mile of haul per 100 pounds of live broilers, if all off-farm facilities are at or near the processing plant. Substantial reductions in these costs are possible as production density is increased and the length of the average haul for a given scale of operations is reduced (Table 1).

2. The optimum sizes for processing plants are related to production densities of supply areas. However, combined transportation and processing costs are not much changed when plant sizes are varied from the optimum (Table 3).

3. Although labor costs for broiler growing may increase with production density, the advantages of greater concentration of broiler growing are sufficiently large that progressive firms can be expected to encourage greater concentration in the future. Present pricing schemes are a hindrance to this concentration under most arrangements involving contract growing.

4. If the use of the broiler litter by-product is limited to fertilization of cropland, the amount of cropland may eventually become a limitation on production density. However, present production areas are far from the saturation point if it is assumed that litter from 1,000 birds can be used annually on each acre of cropland (Table 5).

Further investigations are needed to evaluate potential economies of centralized broiler growing in factory-type operations. Possibilities for improved techniques of feed and bird transport and for uses of broiler litter other than in crop fertilization might be given special attention. In addition, careful studies of economies of scale in chick hatching and feed milling are needed.

CONSUMER ACCEPTANCE OF LEAN PORK

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IT'S time hogs sell for what they're worth."[1] This statement has been repeated dozens of times in the past decade. Although progress at the marketing and production level and at the research level has been very slow, there have been some noteworthy accomplishments.

Aside from the operational problems in the marketing system, there are two valuation problems in selling hogs "for what they are worth." These valuation problems are related to "packer yield" and "retailer yield." First, the hog carcass is a composite of products of varying value. During the past half century the relative values of these products have changed so greatly that a top market hog yielding the highest value today must be quite different than formerly. The prices of the four lean cuts (loins, butts, hams, and picnics) have risen greatly while the prices of fat-for-lard and of certain cuts have fallen greatly. The greater the percentage of the four lean cuts of total carcass weight the greater in general is the yield to the packer. Thus, the first valuation problem is the problem of selling hogs according to their "packer yield."

The difference in value of U.S. No. 1 and U.S. No. 2 grades on the basis of packer yield alone has been calculated as 40 cents per hundredweight in terms of live hog values at Chicago for 1957.[2] While this difference in value provides some incentive to the producer, when and if received, it has not been sufficient to overcome speedily the inertia of a production and marketing system long geared to mine-run buying. A considerable research and extension effort has been devoted to changing marketing practices in order "to sell hogs for what they are worth" in terms of packer yield.

Interest in the second valuation problem has been stimulated by the hope that additional monetary incentives for the production of meat-type hogs might be provided. Several preference studies and the everyday observations of many people indicate a very considerable distaste of most consumers for excessive pork fat. Therefore it is possible that pork cuts from lean hogs can be sold for a higher price at retail and, thus, will yield more returns to retailers than cuts from fatter hogs.

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[1] Title of an editorial in *Successful Farming*, March 1948, p. 3.

[2] Gerald Engelman and Raymond O. Gaarder, *Marketing Meat-Type Hogs*, Mktg. Res. Rep. No. 227, pp. 13-14.

Review of Recent Research

Vrooman, in 1952 in a study of consumer preferences for pork in five western Oregon cities found, "consumers in all five Oregon cities covered by the study expressed a clear-cut preference for lean pork."[3] Fat, medium and lean cuts of pork chops, shoulder steaks, loin roasts, shoulder roasts, side bacon and ham steaks were shown to 221 consumers. More than three-quarters of the consumers chose the leanest cut as their first choice except in the case of ham steaks.

In the winter and spring of 1953-54, Kirtley studied consumer reaction to various price differentials between lean and regular loin and rib chops. Both kinds of lean chops were from "well muscled, lean loins and were labeled 'Extra Lean Chops.'" The regular chops were from fatter loins and were displayed side by side with the leaner ones in one self-service store in Champaign, Illinois. During the six-week test period, at premiums of 10 to 18 cents, the lean chops outsold the regular or fatter ones by a ratio of three pounds lean to two pounds regular. As the premium increased, the lean to regular ratio decreased. Kirtley concluded that consumers have a marked perference for lean pork chops. "Thus, as leaner, well muscled, meat-type hogs are produced it should be possible to sell increased quantities of pork at the same price or the same quantity at a higher price or both."[4]

Kirtley reported that a limited effort to use USDA carcass grades rather than visual inspection as the sorting method was unsuccessful. Lean-fat variation within grades was sufficiently large that inter-grade differences were mainly obscured.

While Kirtley's results were limited to one store, they indicated that "retail yield" from selling leaner cuts might considerably exceed the yield from cuts from fatter carcasses.

A large retail experiment was conducted by Trotter in ten self-service stores in Pittsburgh in 1955.[5] Center-cut pork chops and pork steaks from three carcass grades, A, B, and C—roughly corresponding to U.S. No. 1, 2 and 3—were displayed in eight self-service Kroger stores in paired ribbons. Varying price differentials, ranging from a minus 5¢ to a plus 15¢ per pound applied to the leaner cuts, were employed. In addition, the leanest and fattest grades were displayed in two stores with the price

[3] C. W. Vrooman, *Consumer Report on Pork Products,* Ore. State Col., Sta. Bul. 521, Corvallis, Aug. 1952, p. 14.

[4] M. B. Kirtley, "Consumer Acceptance of Lean Pork Chops," *Ill. Farm Econ. J.* No. 233, June 1955, pp. 1580-82.

[5] C. E. Trotter, "Consumer Preference for Lean and Fat Type Pork Cuts," Ph. D. thesis, Univ. of Minn., 1957. Clarence E. Trotter and Gerald Engelman, "Consumers Fail to Recognize Differences in Pork Grades," *Sci. for the Farmer,* 5:1, Summer 1957, Penn. State Univ.

differential of 10¢ unchanged for the entire test period in an attempt to appraise any change over time in consumer acceptance of the graded cuts. No extra labeling was employed but prices were clearly indicated. The leaner Grade A cuts accounted for approximately 50 percent of total sales irrespective of the price differential.

A sample of 1,100 buyers of the experimental cuts was interviewed. About 40 percent of the buyers were not aware that there were two displays and only 10 percent mentioned that they noticed differences in both prices and degree of lean. Trotter suggests that this failure of many customers to notice differences was partly due to the small differences between product groups.[6] Trotter's results are inconclusive and, in general, are less encouraging than Kirtley's that "retail yield" of lean carcasses is much greater than that of fatter carcasses.

In some small sales tests at Iowa State in 1956, Gaarder and Kline found indications that "hog carcass grading doesn't seem to sort loins into groups that are different with respect to consumer preference."[7] In a later study they report a better relationship of ham grades to store sales. Sales of U.S. No. 1 half hams in three stores in three Iowa cities for two weekends were nearly double the sales of U.S. No. 3 half hams in the same display case at the same price.[8]

Preliminary reports of a pork sales test by Purdue researchers recently became available.[9]

"Tend-R-Leen" meat-type cuts from U.S. No. 1 hogs were sold in five stores for 12 weeks and sales were compared with sales in five other stores of regular pork sold at the same price. "Meat-type pork shoulders outsold 'regular' pork shoulders by 5.6 percent. Nine percent more meat-type bacon, and 13 percent more ham were sold. However, 'regular' pork loin cuts sold no better than meat-type loins."[10]

The differences among cuts are interesting. "In the case of pork loin cuts, such as center cut chops and loin roasts which can be trimmed, consumers showed no preference for the meat-type pork. For cuts such as bacon, hams and shoulders, from which fat cannot be trimmed since most is inside, consumers seemed to prefer the meat type."[11]

Later the "Tend-R-Leen" and regular products were sold side by side

[6] C. E. Trotter, "Controlled Store Experiments" in "Conference on Consumer Preferences," Univ. of Mo. Mim., Sept. 1957.

[7] R. O. Gaarder and E. A. Kline, "What Do Consumers Want From Pork?" *Iowa Farm Sci.*, Dec. 1956, p. 8.

[8] R. O. Gaarder and E. A. Kline, "What Kind of Ham Do People Want?" *Iowa Farm Sci.*, March, 1958, pp. 9-10.

[9] Jim Stevenson and Norton Smith, "Will the Meat-Type Hog Pay Its Way?" *Econ. and Mktg. Inf.*, June 27, 1958, Pur. Univ., pp. 1, 3.

[10] *Ibid.*, p. 1.

[11] *Ibid.*, p. 1.

TABLE 1. CONSUMERS' GRADE PREFERENCES, COLUMBIA, MO., PORK PANEL, 1953

	Choice #1[a]	Medium[a]	No Preference or No Answer
	percent	*percent*	*percent*
	Visual preferences		
Bacon	42.4	54.6	
Ham	47.4	48.7	
Chop	38.5	55.4	
	Preferences after eating		
Bacon	40.8	48.2	11.0
Ham	33.1	49.2	17.7
Chop	39.9	41.5	18.6

[a] Grades as described in USDA Service and Regulatory Announcement No. 171, Sept. 1952. The Medium grade had less finish than the Choice.

in these five stores for a few weeks. Price differences for the same cuts ranged from zero for picnics and bacon to a 10¢ premium on lean center-cut chops. Results are given as a "percentage of pork dollar" spent on regular and meat-type products. Percentages for meat-type cuts were pork loins, 47; fresh Boston butts, 64; fresh picnics, 28; sliced bacon, 17; and cured ham, 53. Poundage sales of lean cuts were obviously considerably less than sales of regular cuts except for Boston butts.

The authors observed that the meat-type pork was more watery and, consequently, had a shorter shelf life in the display counter.

Available data from this study are presently insufficient to evaluate it adequately. At this stage, the results appear to be less favorable to lean pork than Kirtley's report.

The Missouri Agricultural Experiment Station has conducted several studies on consumer preference for pork since 1952. These have taken the form of taste panels, visual preferences, and consumer interviews. Based on these early studies and those conducted at other stations, it was concluded that the variability of pork cuts within the USDA grades was so great as to obviate any potential of a merchandising program based solely on U.S. grades.

Birmingham *et al.*[12] in 1953 interviewed 361 households in Columbia, Missouri. The visual and eating preferences were as shown in Table 1. In about 40 percent of the cases, the respondent's visual preference differed from his eating preference. Birmingham concluded, "the majority of the respondents preferred lean pork."

In 1955, seventy-two randomly selected Columbia households cooperated in a visual and taste preference test of chops and center ham slices.

[12] E. Birmingham, D. E. Brady, S. M. Hunter, J. C. Grady and E. R. Kiehl, *Fatness of Pork in Relation to Consumer Preference,* Mo. Res. Bul. No. 549, May 1954.

Lean and regular cuts were separated on the basis of internal fat, using a photographic standard developed at Missouri. The lean and regular ham steaks or chops were placed side by side on a cardboard backing board and wrapped in cellophane. The housewife was asked to indicate which she preferred. The slices or chops were then prepared in the household and the two adult members indicated their taste preference.

On the basis of visual preferences, the leaner rib and blade chops and ham slices were each preferred by about two-thirds of the respondents. However, on the basis of eating preferences there was little consistent difference in the chops, and the fatter ham slices were slightly more popular.

Photographs had been made of representative side-by-side comparisons used in the study described above. These pictures of lean and regular ham slices and chops were shown to about 300 shoppers in three of the supermarkets in Columbia, Missouri in early 1956. They were then asked which they would buy if both were priced alike.

The ham slice with the smaller amount of internal fat was preferred by a ratio of 2 to 1. The blade chop with the smaller amount of internal fat was preferred by about 80 percent. All interviewers were impressed by the widespread desire to avoid excess fat in pork as indicated by the numerous comments as well as the preferences.[13]

It was concluded from these studies that the visual differences in these ham and loin standards were sufficiently large that most consumers could discriminate. The inconclusiveness of the eating results suggested that palatability was not noticeably related to the visual standards. Thus it appeared likely that an experimental sales test would be useful. Visual preferences were obviously quite important and it appeared likely that eating experiences would not be different from those anticipated by the purchasers. The difficulties of interpreting sales test results when eating satisfaction may not have been correctly anticipated have been discussed elsewhere.[14]

Kansas City Pork Merchandising Test[15]

The objective was to measure under realistic merchandising conditions the relative sales of selected pork products varying in amount of internal fat. Rather than subdivide the data among many products, several price differentials, and several merchandising conditions, it was decided to choose three products, one price differential, and one set of merchandising

[13] Unpublished data, Univ. of Mo.

[14] V. James Rhodes, "The Measurement of Consumer Preferences," *J. Farm Econ.*, Nov. 1955, pp. 648-9.

[15] For a more detailed discussion of methods and results see a forthcoming publication: H. D. Naumann, E. A. Jaenke, V. James Rhodes and D. E. Brady, *A Large Merchandising Experiment with Selected Lean Pork Cuts*, Mo. Res. Bul. 711 (in press).

conditions. A great variety of problems was ignored in order to obtain more power in answering the few problems attacked.

Various pork products were considered for a sales test. The particular interest of the cooperating packer encouraged selection of the ham shank portion and ham slices. The rib end loin roast was chosen as a fresh cut with considerable variation in internal fat. While it would have been interesting to use rib and loin chops as well as roasts, the extra record-keeping problems appeared too great.

Procedure

Retail store experimental design

Fourteen supermarkets of a national chain in the Kansas City metropolitan area were used for the sales test. These fourteen stores were divided into three groups as follows:

Group I stores. This group of eight stores displayed all three of the test products—rib end loin roasts, shank end smoked hams and center-cut ham slices.[16] The test products were in a side-by-side, paired-ribbon display. The position of each paired display within the meat case was determined by normal chain-store merchandising procedure. The position of lean and regular cuts of a particular test product was rotated weekly to eliminate any effect of position. The two treatments applied to this group of stores were:

> Treatment C—The lean product with no distinctive labeling, priced the same as the prevailing chain price, and sold alongside the regular products.
> Treatment D—The lean product, labeled "Selected Meat Type Pork," priced 4¢ above the prevailing chain price, and sold alongside the regular product.

These treatments were rotated within the eight stores every two weeks throughout the study.

Group II stores. This group of four stores displayed only shank end smoked hams in the test. To reduce customer comparison, the displays of the product were separated, generally by a distance of four to six feet.

The original purpose of this phase of the test was to determine the feasibility of a retail store handling only one type of pork. Since the cooperating chain would not permit the sale of only one type of pork, it was assumed that by separating the cuts by 15 to 20 feet the single stimulus test might be approximated. However, practical limitations of meat counter space prevented so wide a spacing.

The treatments used in Group II stores were:

> Treatment A—The leaner product, labeled as "Selected Meat Type Pork,"

[16] A shortage of slices limited displays to six stores.

in the preferred "first" position and priced 4¢ above the prevailing chain price. The regular product was four to six feet distant in the "second" position.

Treatment B—Same products, pricing and labeling but the regular product in the preferred (first) position.

Group III stores. A third group of two stores displayed lean and regular loin roasts and shank hams in side-by-side displays for the full eight weeks. The relative position of the lean and regular cuts was rotated weekly to remove effect of position. During the entire test the lean cuts were labeled "Selected Meat Type Pork" and were priced 4¢ above the prevailing Kansas City chain price (4¢ above the regular). The purpose of the Group III experiment was to observe the development of sales under constant conditions for the full eight weeks.

The displays were sufficiently close in the Group II stores that the experimental situation was very much the same as in the Group III stores, excepting that only shanks were displayed in the former.

Selection of stores

The individual stores used in this study were selected in cooperation with the chain store management so as to provide as nearly as possible a representative sample. The 14 stores had self-service meats, represented various customer groups as to race, nationality and income, and had local managements who were anticipated to be cooperative. Total weekly volume of meat sales per store ranged from $1,400 to $4,100 and weekly customer count ranged from 2,000 to 4,500. Seven of the stores were modern supermarkets while seven were of the older, neighborhood type.

Grading and handling at the packing plant

The retail cuts used in this study were from hogs slaughtered and processed at the plant of the cooperating packer. The carcasses were first sorted by hot weight and backfat measurements and later graded by the backfat measurements shown in Table 2.

The loins, usually in the 10- to 12-pound weight class, were graded as they came off the cutting line on the basis of the photographic standards. This photograph served to delineate the breakpoint—i.e., any loin with a larger proportion of internal fat than was present in the photographic standard was classified as a "regular" and those loins with a smaller proportion of internal fat were graded "lean."[17]

[17] The presence of a relationship, although a rather weak one, between pork grades based on backfat and the internal leanness of the cuts is shown by the percentage yield of "lean" hams and loins, respectively: U.S. Medium, 61 and 64; U.S. No. 1, 48 and 53; U.S. No. 3, 35 and 29.

TABLE 2. SPECIFICATIONS USED IN SELECTING TEST PRODUCT AND THE EXPECTED RETAIL GRADE

Hot Carcass Weight	Chilled Carcass Average Backfat Measurement[a]	Test Grade	Retail Grade[b]
pounds	*inches*		
140–160	1.0–1.3	0	Lean
	1.3–1.6	1	
156–175	1.6–1.9	2[c]	
	1.9–2.2	3	Regular
	2.2–2.5	4	

[a] Average of measurements at first rib, last rib and last lumbar.
[b] Retail grades "lean" and "regular" were classified on the basis of the photographic standards from all the test grades.
[c] Grade 2 was used only when carcasses from 3 and 4 did not yield an adequate supply of retail grade regular.

Grading and handling at retail level

Rib end loin roasts were removed from the whole loin at the store by making a cut between the sixth and seventh rib. Any necessary trimming was made, leaving an attractive two and one-half to three and one-half pound roast. The roasts were then wrapped in clear film, sealed, weighed, priced, labeled, and readied for display in the meat case by the regular personnel of the stores.

The whole hams were cut on the power saw, the point of break approximately one inch below the aitch bone. The butt half was channeled into non-test sales. Approximately two inches of the shank half was removed to be used for center slices. The shank end ham portions were packed in polyvinylidine chloride bags and cry-o-wrapped ready for retail sale. As the shank end hams came through the cry-o-vac process University of Missouri personnel assigned retail grades.

Collection of sales data

The sales test was conducted continuously from June 11 to August 6 in 1956. A week of pretesting preceded, during which many of the problems of supply, display, training, record keeping, etc., were resolved.

During the eight-week test period each store was checked daily by University of Missouri personnel. On each Monday, Wednesday, and Friday two University representatives and the coordinator took complete inventories and computed the sales for the preceding sale period. Each store was inventoried at approximately the same time of day throughout the study.

Sales data gathered in certain inventory periods or portions of some inventory periods had to be discarded because correct experimental procedures were not strictly adhered to. In most of the cases of discarded

TABLE 3. ACTUAL PRICES (CENTS PER LB.) OF TEST PRODUCTS

Shank Portions		Loin Roasts		Ham Slices	
Date	Price of Regular[a]	Date	Price of Regular	Date	Price of Regular
6/11–6/14	49	6/11–6/14	49	6/11–8/6	99
6/15–6/16[b]	39	6/15–6/17[b]	45		
6/17–7/19	49	6/18–6/24	39		
7/20–7/21[b]	39	6/25–7/5	35		
7/22–8/6	49	7/6–7/12	49		
		7/13–7/14[b]	39		
		7/15–8/6	43		

[a] Lean prices 4¢ above regular or same as regular.
[b] Friday and Saturday Sales—usually accompanied by advertisement in Kansas City newspapers.

data the displays of the test products were inadequate. Over the eight-week test period, the 14 stores had a combined total of 336 inventory periods. Of these, only 12 complete inventory periods were discarded.

In other cases, portions of an inventory period had to be dropped from the test. Wherever a store was visited on noninventory days and one of the test product displays was approaching the minimum standards, an inventory was taken and further sales were not recorded until the displays had been replenished. While the minimum display requirements varied under different circumstances, generally it was required that at least three representative cuts of each grade be on display in order for the sales data to be used.

The basic price level of the test products was determined and adjusted by the cooperating chain store in accordance with their normal procedures. In instances where a premium was placed on the "lean" cuts this price was 4¢ above the price of the "regular" cuts. Table 3 gives the actual prices charged during the time the test was conducted.

An experienced meat cutter and buyer in the chain store organization was assigned as coordinator. Throughout the study, the knowledge and personality of the coordinator as well as the respect and popularity he generated among the store employees made him invaluable in handling different problem situations.

Sales Results

Lean to regular sales for all stores

During the eight-week test, sales data were gathered on almost 44,000 pounds of meat in the 14 stores. Since a paired display of lean and regular was in all stores at all times, sales ratios of lean and regular can be usefully computed for all stores. Breakdowns of these ratios by factors affecting these sales ratios will be made later.

Physical sales of each lean product exceeded sales of its regular counterpart, although the excess was a very modest one for center slices (Table 4). The lean to regular ratios are more favorable in dollars than in physical terms because of the 4-cent premium often obtained on the leaner cuts. Approximate gross sales of lean and regular, respectively, were as follows: shank portions, $8,960 and $6,690 (ratio of 1.34 : 1); loin roasts $1,160 and $910 (ratio of 1.27 : 1); ham slices, $3,520 and $3,210 (ratio of 1.10 : 1); all cuts, $13,640 and $10,810 (ratio of 1.26 : 1). While the lean retail yield exceeded the regular retail yield when both were sold side by side, there is no evidence as to comparative retail yields if either had been sold alone. It should be remembered that revenue totals were affected by the particular size of the differential and by the proportion of time it was in effect.

Rate of total shank portion sales per 4-week periods in the 14 test stores were almost double the rate of sales in a similar period just prior to the test. The increase should probably be attributed mainly to larger, better supervised displays. Perhaps the presence of both lean and regular products also contributed to the higher sales.

A further breakdown of the over-all sales by two-week periods shows the trends in sales over the eight-week period (Table 5). The rib end loin roasts sold at about the same lean to regular ratio throughout the study. The lean to regular sales ratio of shank portions increased considerably as the study progressed. Lean to regular sales ratios on center ham slices varied only slightly during the test, with no consistent trend in evidence.

It was observed during the early part of the experiment that (1) the regular test products appeared to be a little leaner than the bulk of the products being sold in other stores of the chain, and (2) that the lean-regular sales ratios might be hampered by the absence of any "gap" between lean and regular which could aid consumer discrimination. It was, therefore, decided that at the end of four weeks the very leanest portion of the regular products would be eliminated from the displays. A second set of pictures was used, so that the leanest end of the regular

TABLE 4. TOTAL SALES AND LEAN-TO-REGULAR SALES RATIOS OF TEST PRODUCTS SOLD DURING TEST PERIOD, ALL STORES

Test Product	Lean		Regular		Ratios	
	No.	*Lbs.*	*No.*	*Lbs.*	*No.*	*Lbs.*
Loin Roasts	826	2,692	664	2,177	1.24:1	1.24:1
Shank End Hams	2,860	18,072	2,389	14,228	1.20:1	1.27:1[a]
Center Ham Slices[b]		3,490		3,244		1.08:1

[a] Sales ratios by number and pounds vary for shank portions because lean and regular average weights were 6.3 and 5.9 pounds, respectively.

[b] Data on center ham slices consisted only of total pounds sold because center ham sections were cut in slices of various thickness.

TABLE 5. LEAN-TO-REGULAR SALES RATIOS BY TWO-WEEK PERIODS, ALL STORES

Two-Week Periods	Loin Roasts		Shank End Hams		Center Ham Slices
	No.	*Lbs.*	*No.*	*Lbs.*	*Lbs.*
June 11–June 24	1.25	1.25	1.08	1.05	1.12
June 25–July 8	1.28	1.26	1.17	1.24	1.04
July 9–July 22	1.19	1.21	1.24	1.33	1.08
July 23–August 5	1.23	1.24	1.44	1.62	1.05

and the fattest end of the lean were separated by a short gap. Since display positions were rotated weekly and treatments were rotated bi-weekly, the product changes were possible without other adjustment. However, the product change does greatly complicate any inferences as to trend in sales ratios over time.

As shown in Table 6, the lean-regular sales ratios increased from the first to the second four-week period for shank portions with or without a price difference and for loin roasts with a price difference. Explanations as to these variations in results are largely conjectural. The lean and regular center ham slices were not markedly different in appearance, and the presence or absence of 4-cents-a-pound premium on a $1.00 item was a relatively minor matter. How much of the increase in the shank portion ratio should be attributed to the slightly fatter regular product in the second period and how much should be attributed to rising repeat sales of the lean? Any optimistic answer must be tempered by the decline in the loin roast ratio when there was an absence of a price or label difference in the second period.

Results with no difference in price or label

The number of lean shank portions sold was 59.7 percent of the total; the weight of lean ham slices was 52.1 percent of the total; and the number of lean loins sold was 58.3 percent of the total when there was no difference in price or label.

TABLE 6. LEAN-TO-REGULAR SALES RATIOS BY FOUR-WEEK PERIODS, ALL STORES[a]

	Loin Roasts	Shank Portions	Center Ham Slices
	I. When No Price or Label Difference		
June 11–July 8	1.66:1	1.29:1	1.10:1
July 9–August 5	1.14:1	1.69:1	1.08:1
	II. When a Difference in Price and Label		
June 11–July 8	1.09:1	1.01:1	1.07:1
July 9–August 5	1.25:1	1.13:1	1.06:1

[a] Slice ratios computed from data in pounds; other ratios, from data in number of pieces.

TABLE 7. SALES OF SHANK PORTIONS BY STORE GROUP WHEN A DIFFERENCE IN PRICE AND LABEL

Store Group	Lean	Regular	Lean-to-Regular Ratio
I. Side-by-side displays; 8 stores	844	849	.99:1
II. Separated displays; 4 stores	506	451	1.12:1
III. Side-by-side displays; 2 stores	392	338	1.16:1
Total	1,742	1,638	1.06:1

Results with a price and label difference

In one-half the Group I stores at any given time and in all Group II and III stores all the time, the lean products were labeled "Selected Meat-Type Pork" (in addition to regular store labels) and priced 4 cents a pound above the regular price.[18]

In all groups, physical sales of the higher-priced leaner products equaled or slightly exceeded the sales of the regular products. The "retail yield" of lean cuts exceeded the retail yield of regular cuts in all groups (Tables 7 and 8). While number or amount of sales cannot be equated exactly with number of buyers, it appears that about as many buyers were willing to pay the 4-cent premium as were not.

It can be postulated that buyers did not pay any attention to price and that sales were about equal because of random selection. There are two arguments against that hypothesis. First, the consistently smaller ratios with a price difference than with the same price indicates that price had its expected effect on behavior. Second, most buyers examined more than one package of the product. A staff member unobtrusively but systematically observed buyer behavior for parts of one, or usually two, days in each test store. These observations were not obtained by a systematic sample of the test period and may not be entirely representative. Of the 209 customers who paused at the test displays, 77 percent examined more than

TABLE 8. SALES OF HAM SLICES AND LOIN ROASTS BY STORE GROUP WHEN A DIFFERENCE IN PRICE AND LABEL[a]

Cut	Store Group	Lean	Regular	Lean-to-Regular Ratio
Slices	I. 8 stores	1,778	1,672	1.06:1
Roasts	I. 8 stores	281	237	1.18:1
Roasts	III. 2 stores	215	191	1.12:1

[a] Slice data is in pounds; other data is in number of pieces.

[18] Since almost any special merchandising of lean pork will involve special labels, a small label was used in this test. Obviously, results might have been different with a different label or without a label.

one package. Of the 92 purchasers, all but two examined more than one package. Twenty-two of these 92 purchasers did not examine both lean and regular packages. While the degree of customer awareness of the test variables cannot be accurately measured, it appears that selection was preceded by some examination of both lean and regular packages by more than three-fourths of the purchasers. While the degree of examination in selection appears higher than that found in Pittsburgh by Trotter, it is true that some selections were made without regard to the test variables. What would be the effect on repeat sales if the "superficial shopper" found at the time of carving that he had a leaner product? The only clue —an inadequate one—is that lean shank sales trended upward during the test as was shown.

Most of these results are consistent with a model in which a minority of buyers select without inspecting both displays, another small minority select carefully for lean, and a majority consider a number of factors including possibly size, color, total price, shape, and fatness. Sales ratios will not vary quickly nor widely away from 1:1 in such a situation when one or two variables like fatness and price are quietly varied by relatively small amounts.

Effects of price and labeling, store, and display position on sales ratios

Treatments C and D (C = no price and label difference, D = price and label difference) in the 8 Group I stores had a significant effect on the shank portion sales ratios but not on the loin roasts or ham slice ratios. The shank portion ratio was 1.48 : 1 for Treatment C and 0.99 : 1 for Treatment D.

An analysis was made of lean and regular sales in pounds and dollars per 1,000 customers, and also of dollar sales as a percent of total meat sales. As indicated in Table 9, the excess of lean over regular in Group I stores was larger for all 3 products when there was no price difference.

Total lean plus regular sales (pounds, dollars, percent of total meat sales) were greater for shanks and loins when price was the same than with a different price, but the reverse was true for center slices. The increase of approximately 8 percent in the prices of shanks and loins apparently discouraged their purchase more than the increase of approximately 4 percent in the price of slices discouraged their purchase.

As another method of comparing the price effects, coefficients of cross-elasticity were estimated for sales in Group I stores. The percentage change in the price of lean in the C and D experiments was divided into the percentage change in the pounds of regular product sold (in the entire test and also per 1,000 customers). Coefficients of cross-elasticity for shank, slices, and loins, respectively were approximately 1.49, 1.56, and

TABLE 9. SALES OF LEAN IN EXCESS OF REGULAR, BY STORE GROUP

	Pounds per 1,000 Customers	$Per 1,000 Customers
When Same Prices		
Shanks (Group I)	10.6	$4.94
Slices (Group I)	1.2	1.15
Loins (Group I)	1.2	.41
When Different Prices		
Shanks (Group I)	.8	$1.35
Shanks (Group II & III)	3.8	2.63
Slices (Group I)	.2	.63
Loins (Group I)	.6	.38
Loins (Group III)	.3	.22

−.36 for the entire test, and 1.64, 2.04 and −.26 per 1,000 customers.

The comparative responsiveness of the sales ratios of the three cuts is poorly related to these cross-elasticity coefficients primarily because the latter were not affected by changes in sales of lean.

The high coefficient for slices was caused by the fact that the percentage price change (the divisor in the computation) was only 4 percent for slices while it was approximately 8 percent for the other cuts. Thus, the small absolute response of the sales of slices to the price change appears as significant as the larger absolute change in sales of shanks when cross-elasticities are computed. A slight decline occurred in regular sales when a price premium on lean produced the negative cross-elasticity for loins.

A considerably better index of the impact of price ratio changes on sales ratio changes was obtained by this index:

$$\text{Ratio-elasticity} = \frac{\text{percentage change in sales ratio}}{\text{percentage change in price ratio}}.$$

Thus the lean to regular sales ratio of ham slices declined from 1.09 : 1 to 1.06 : 1 with a rise in the price ratio of lean to regular from 1 : 1 to 1.04 : 1. The 2.8 percent decrease in sales ratio divided by the 4.0 percent increase in price ratio yields an index of −.7 for loin roasts. This index, like other arc elasticity coefficients, is asymmetrical for price ratio increase and decrease.[19] The values below were computed by averaging the indices for price ratio increase and decrease.

The indices of ratio-elasticity obtained were shanks −5.0, loins −1.8, slices −.7. To appraise these values, the reader may readily discover for himself that this index has a value of zero for independent goods, positive values for complementary goods, and negative values for substitutes. The larger the ratio-elasticity, the greater the responsiveness of the sales ratio

[19] Sidney Weintraub, *Price Theory*, (New York: Putnam Pub. Co., 1949), pp. 47-49.

to price ratio changes. However, for goods which are perfect substitutes any deviation of the price ratio from 1 : 1 results in a sales ratio with zero in the numerator or denominator.[20]

Sales ratios by display position did not differ significantly. However, they closely approached statistical significance for loin roasts in the Group I stores. The interaction of stores and position was significant for the 6 stores in Group I carrying slices. In 3 stores the sales ratio was higher for lean in the first position and in 3 stores for regular in the first position.

Opinions of store managers and head meat cutters

At the conclusion of the study the store managers and head meat cutters of the test stores were asked to complete a questionnaire pertaining to their opinion of the potential of retailing leaner pork. The concensus of these key personnel was that pork sales would increase considerably if leaner pork were displayed. They felt that over a longer period, sales volume of leaner pork cuts would be three times that of the regular cuts. Their opinions appear to be overly optimistic.

Appraisal and Suggestions

With the advantages of hindsight the authors would suggest three specific changes in the design of the study which would have been possible within the context of institutions and resources present. First, the Group II stores should have been included in Group III because there was insufficient isolation of displays to simulate effectively the conditions for single-stimulus sales. Second, the small "gap" between lean and regular products should have been present for all eight weeks rather than just the last four. Third, when there was a price difference, there should have been larger labels and point-of-purchase material to call the attention of more purchasers to the presence of two products at two prices. It is debatable whether such point-of-purchase material should have been available when the prices were the same. Sales data in the latter situation would be useful but perhaps no more so than those obtained.

Suggestions for future experiments would include a longer time period, a single-stimulus design for at least part of the stores, considerable merchandising and promotion effort,[21] and differences between products

[20] This index of ratio-elasticity might have some general usefulness as a substitute for, or complement of, the cross-elasticity coefficient in studies in monopolistic competition.

[21] This suggestion is not motivated by a desire to change consumer wants and to create a preference for lean pork even if none now exists. It is rather assumed that in an "affluent society" the attention of the consumer must be drawn to possibly improved products if we are to learn whether or not she considers them to be actual improvements.

which are as wide as practicable.[22] The importance of both adequate supervisory personnel and an environment which encourages the whole-hearted cooperation of all packer and retail personnel cannot be over-estimated. Because the problem is one of market development over time, the most useful experiment might be a test for 8 months or more in several stores with some stores selling both lean and regular and others selling lean. It may be that the off-and-on latin square design is not nearly as well suited to this problem of a long-time development of a premium market for pork as it is to some other problems.

Implications for National Policy from Acceptance Studies

How much can the attitudes and preferences of consumers contribute to the solution of the fat pork problem? It is generally indicated by these studies and by everyday observation that part of the pork problem arises from those consumer preferences. The hope has often been expressed that consumer preferences are of such nature that some—perhaps many—retailers would find it profitable to sell lean pork, either alone or in combination with regular pork, at a premium price. There was the further hope that this premium would be quickly shared with other marketing elements including producers in such fashion as to give consistent financial incentive to the production and marketing of much meatier hogs than presently produced.

Pork acceptance tests indicate that the first hope is a tenable one, but they also suggest that the development of a substantial premium market for lean pork may require considerable merchandising effort over a long period of time. Descriptions of pork and bacon merchandising in Canada and the United Kingdom clearly indicate that those consumers are accepting a very lean pork. "The regular style of trim is rapidly decreasing in importance in Canada, however. More and more cuts are being completely boned and defatted. The largest Canadian packing firm reported that more than 50 percent of its hams and butts were sold in this manner."[23] "Rolled and boneless cuts must be sold at higher prices per pound retail weight to compensate for some extra labor and for the loss in weight of the bone and fat removed. Canadian customers have apparently been educated to accept this fact."[24]

The second hope of a quick, consistent, and significant premium for meatier hogs based on consumer acceptance does not appear realistic.

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[22] In order to offer realistic choices the "gap" between products should not be sufficiently wide as to exclude over one-fourth or one-third of the hog carcass population.

[23] Engelman and Gaarder, *op. cit.*, p. 27.

[24] *Ibid.*, p. 29.

The development of a substantial premium market for meatier pork cuts is likely to take several years at best, and perhaps much longer. While some progress is being made toward producing meatier hogs, it is difficult to believe that much important progress will be made until there is a reliable price incentive.

If the current market structure cannot develop and promote the apparent market for meatier pork, serious consideration might be given to adapting the Canadian system of quality premiums. A government premium a little larger than the Canadian one of $2 per Grade A carcass and $1 per Grade B carcass[25] would provide the needed price incentive for rapid adjustment. The effectiveness of such a premium in giving impetus to the American meat-type hog program should be obvious. It appears just as obvious to many observers that such a premium would not encounter the opposition of the majority of farmers. Even those producers who fear that they produce too few premium hogs to benefit from sorting before selling in today's markets would gain under a program of government premiums.

This quality incentive program should be set up for a definite period considered long enough to encourage a substantial increase in the production of lean pork—say five years. During this time lean pork will become readily enough available to enable retailers and consumers to exercise more realistic choices between lean and regular pork. A retail premium will or will not develop for lean pork depending entirely upon consumers' preferences and upon retailer attitudes. If a premium market for lean pork has not developed at the end of this incentive period, then no such market is probably justified and the meat-type hog program must depend entirely on packer yield for its economic justification. If a premium[26] market for lean pork becomes established, then a more efficient hog production and incentive system and an improved satisfaction of consumer preferences will have been obtained than now exist. In view of the primary importance of the domestic market to U.S. producers, there appears to be no justification for a permanent quality incentive program in this country.

[25] *Ibid.*, p. 26.

[26] The premium must be sufficiently large to more than pay the extra costs to processors and retailers of separating out the lean pork.

COLLECTIVIZATION IN HUNGARIAN AGRICULTURE*

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Agricultural Policies in the Postwar Period

AGRICULTURE plays an important role in the Hungarian economy. In the thirties, 49 per cent of the population was engaged in agricultural pursuits, in 1949, 48 per cent, and in 1955, 44 per cent; while the percentage of national income stemming from agriculture was 36 in 1936-37, and 30 in 1955.[1] Prewar Hungary was characterized by extensive cultivation and by an uneven distribution of landownership. Large estates and dwarf holdings were predominant and about 35 per cent of the agricultural population were landless peasants. Sweeping changes were brought about by the 1945 land reform, which affected 3.2 million hectares, about one-third of the country's land area. Large estates over 576 hectares were expropriated, holdings between 57.6 and 576 hectares were reduced to

TABLE 1. THE DISTRIBUTION OF LAND-HOLDINGS

Farm Size (in Hectares)	1935				1946			
	Number (in Thousands)	Percentage	Area (1000 Hectares)	Percentage	Number (in Thousands)	Percentage	Area (1000 Hectares)	Percentage
Dwarf farms (–2.85)	1,185	72.5	930	10.1	1,406	68.1	1,637	17.9
Small farms (2.85–5.7)	204	12.5	842	9.2	388	18.8	1,932	21.1
Medium farms (5.7–28.5)	218	13.3	2,380	26.1	247	11.9	2,935	32.0
Large farms (28.5–)	27	1.7	5,002	54.6	25	1.2	2,663	29.0
Total	1,634	100.0	9,154	100.0	2,066	100.0	9,167	100.0

Source: *Hungarian Statistical Handbook*, 1948.

* The manuscript was read in its various stages by William Fellner, John M. Montias, Lloyd G. Reynolds, and Robert Triffin. I am indebted to them for comments and criticism. The material of this article will be used in my forthcoming book, *The Hungarian Experience in Economic Planning*. (To be published by Yale University Press.) The article covers the postwar period up to the outbreak of the Hungarian Revolution (October 23, 1956).

[1] *Népgazdasagi mérlegek, reáljövedelmek (National Income Accounts, Real Incomes)*, 1956. Central Statistical Bureau, Budapest, 1957. p. 9. (In the following, this publication will be cited as *National Income Accounts*). M. Matolcsy and S. Varga, *The National Income of Hungary* 1924/25-1936/37. London, King, 1938. *Statisztikai Évkönyv (Statistical Yearbook)*, 1949-1955, Budapest, 1957. p. 39. In regard to national income data the Marxist definition of national income (the net value of material production) is used in the estimates.

57.6 hectares, or, in the case of peasant-proprietors, to 115 hectares. Some 642,000 families (landless or land-poor) received an average allotment of about 3 hectares, the remaining 1.3 million hectares (including 0.8 million hectares of forest) being retained for public use.[2]

The comparative distribution of land-holdings, before and after the Second World War, is given in Table 1. It should be noted that a considerable proportion of the dwarf farms belonged to industrial workers and craftsmen who cultivated their land plots in their spare time. Healthy development in the distribution of holdings is indicated by the increase in the average area of small farms from 4.1 to 5.0 hectares and in the average size of medium farms from 10.8 to 12.0 hectares. In 1946, the large holdings, with few exceptions, were state farms.

After the land reform, the course of the future development of agriculture had to be decided. The predominance of small farms and the high density of the agricultural population pointed in the direction of intensive cultivation. The idea was not new; in the thirties it had become widely held that in Hungary one of the major preconditions for increasing national income and living standards required the promotion of labor-intensive crops. The plan was advanced that Hungary should concentrate on vegetables, fruits, industrial crops, dairy products, and livestock. It was intended to transform Hungarian agriculture along the lines of the Danish pattern.[3] Intensive cultivation seemed to be necessary not only to increase the income of the population as a whole but also to ensure the viability of the small farms, since before the war many holders of small land plots had had to supplement their meager incomes by working part time for the great landowners. Yet political considerations steered the courses of development in a different direction.

Following the Soviet example, the Hungarian policy-makers endeavored to establish large state and collective farms in place of private holdings. Development of intensive cultivation had to give way to collectivization, with emphasis on extensive farming.[4] In the shaping of agricultural policy, differences in natural endowment between the two countries were neglected. Hungary, with her population density of 280 persons per square mile, faces different problems from those of the Soviet Union, with a density of 24 per square mile. In the latter, land being abundant, extensive farming may be economical, as it is on the great plains of the United States or in Australia. On the other hand, land being scarce in Hungary,

[2] *Magyar Statisztikai Zsebkönyv (Hungarian Statistical Handbook)*, 1948.

[3] I. Kovács, *Agrárpolitikai feladatok (The Tasks of Agricultural Policy)*, (Budapest, 1946), pp. 33-35.

[4] For comparison: In 1955, 57.2 per cent of income of the individual farmers and 37.7 per cent of income of collectives came from agricultural activities other than crop cultivation (*National Income Accounts*, p. 117).

TABLE 2. COLLECTIVE FARMS IN HUNGARY

End of the Year	Number of Collectives	Area of Collectives (1,000 Hectares)	Membership (Thousands)	Percentage of the Active Population in Agriculture
1949	1,367	182	36.4	1.7
1950	2,185	445	119.5	5.7
1951	4,625	1,002	310.5	15.1
1952	5,110	1,502	369.2	19.1
1953	4,536	1,144	250.0	13.1
1954	4,381	1,083	230.0	11.8
1955	4,816	1,314	305.5	15.3
1956	2,089	597	119.3	5.9

Source: *Statistical Yearbook* (1949–1955), p. 57, 187. *Statisztikai Havi Közlemények* (Monthly Bulletin of Statistics), No. 1 (1957) 34.

high productivity of land is the proper objective. Furthermore, the Hungarian soil and climate are suitable for horticulture, viticulture, etc., and markets can be found for these products.[5] These arguments had little effect on the policy-makers, and the decision was for collectivization.

The Socialist Sector

The first collective farms[6] were established at the beginning of 1949 and the following years witnessed the forced collectivization campaign. Some representative figures on the collective farms are presented in Table 2. The fluctuation in the figures is a clear indication of changes in the vigor of collectivization policy. A "tough" policy was followed until 1953, when the New Course halted forced collectivization and permitted the dissolution of collective farms if the majority so wished. Although in some areas these directives were not carried out, the membership of the collectives decreased by almost 40 per cent. In 1955 the return to the Stalinist line had as a corollary the renewal of the drive for collectivization. Further efforts to collectivize were made in the first half of 1956.

[5] The need for intensive cultivation was emphasized again immediately before and after the Revolution. *Szabad Nép (Free People)*, October 18, 1956, and *Közgazdasági Szemle (Economic Review)* Nos. 11-12 (1956), 1286, *Ibid.*, No. 7 (1957), 546, 711.

[6] The following types of collective farms were established:

Type I. Collective plowing and sowing of plots grouped in land compounds; individual harvesting. Cost of plowing and sowing burdens each member according to the land contributed; the crop belongs to him after the reduction of this cost.

Type II. Collective plowing, sowing, harvesting and threshing. Proportionate distribution of net receipts according to the land contributed.

Type III. Both land and means of production common property; each member paid according to work-units, no land rent.

In Hungary, the last mentioned two types are of main importance. In the following no distinction will be made between the various forms of collective farms.

By September 1956 the number of collective farms (4,857) almost reached the 1952 peak and the area of these farms rose to 1,459,000 hectares.[7] Parallel with the increased efforts to collectivize, discontent in the countryside mounted sharply. As Z. Tildy, former president of the Hungarian Republic, said, "I know that to speak about collectives is, unfortunately, the most unpopular thing in Hungary."[8] The events during and after the Revolution bore out Tildy's assertion. It had been estimated that about 90 per cent of the collective farms were expected to disband, and after the Revolution was crushed by the Soviet army—in spite of the efforts to maintain collectivization—more than 60 per cent of the members chose the road to private farming. By the end of 1956, after many years of forcible collectivization, membership was less than at the end of 1950 and had fallen to less than one-third of the peak figure reported in 1952.[9] Psychological reasons and the profit motive are primarily responsible. The Hungarian peasant is characterized by his strong individuality, hence his dislike for the kolkhoz. If he entered a collective as a result of direct or indirect coercion by the state, the peasant was inclined to work less, since he felt no direct connection between his work and his remuneration. Instead, he concentrated effort on the household plot allotted to him and endeavored to increase, for example, his poultry production. It has been reported that the disinterest in collective work resulted not only in reduction of working hours but also in deterioration of the quality of work performed. The management of the collectives also left much to be desired. The Chairman (nominally elected by the members but often actually chosen by the district's Party Secretary) was selected primarily through political considerations. In many large collective farms these positions were filled by industrial workers sent from the towns by the Party, who were politically reliable but had neither knowledge nor experience in agricultural work.[10]

Alongside the efforts to collectivize individual holdings, the number and area of the state farms were also increased. Most of these farms were established in 1950-52, mainly on land expropriated from the kulaks or

[7] *Monthly Bulletin of Statistics*, No. 1 (1957), 34.

[8] *Szabad Nép*, October 19, 1956.

[9] Most of the remaining members were landless peasants for whom the collective farm established on, for example, former kulak holdings was attractive. On this point cf. N. Spulber, "Collectivization in Hungary and Romania," in I. T. Sanders, ed., *Collectivization of Agriculture in Eastern Europe* (University of Kentucky Press, 1958), p. 154. Since 1957, the membership has increased again, primarily as a result of political pressure.

[10] In 1954, 400 former industrial workers were put in leading positions. *Adatok és adalékok a népgazdaság fejlödésének tanulmányozásához (Facts and Figures for the Examination of the Development of the National Economy)*, Central Statistical Bureau, Budapest, 1957. p. 242. (Hereinafter cited as *Facts and Figures*).

TABLE 3. STATE FARMS IN HUNGARY

Middle of the Year	Area of State Farms (Thousand Hectares)	Percentage of Agricultural Land
1949	177	1.2
1950	642	6.3
1951	973	6.6
1952	1,441	9.7
1953	1,698	11.4
1954	1,700	11.4
1955	1,640	11.1

Source: *Statistical Yearbook*, 1949–1955, pp. 154–57. These figures do not comprise the state farms engaged in forestry, which constitute an additional 13 per cent of agricultural land in state-management during the period under consideration.

abandoned by small farmers. The growth of the state farms is indicated by Table 3.

Before the war the state farms served special purposes, such as horse-breeding and production of improved grains. The new state farms concentrated on field crops to take the place of production on the former giant estates. Frequent complaints were raised against the inefficiency of state farms. Poor standards of management, inadequate wage systems, and lack of incentive were mentioned frequently as the main causes of the shortcomings.[11] In the selection of managers political considerations played a much greater role than in industry. The agricultural specialists who formerly worked on the large estates were not hired; agronomists trained in short courses assumed many of the leading positions. The piece-rate wage system was not a felicitous choice either; it resulted in work of lower quality and disproportionate wages, because of differences in soil conditions and in the help received from the supervisor in evaluating work performance.

TABLE 4. NET PRODUCT PER ACRE

	State Farms (without forestry)	Collective Farms	Individual Farms	Together
	Forints	*Forints*	*Forints*	*Forints*
Crops (including horticulture, orchards, vineyards)	2,186	2,510	3,003	2,559
Livestock	1,602	1,606	2,482	1,896
Other	28	16	20	17
Together	3,816	4,132	5,505	4,472

Source: *Statistical Yearbook*, 1949–1955, p. 109. It should be noted that the price-weights used in effecting the calculations cited have not been disclosed and changes in price-ratios may substantially modify the results. In this table and on the following pages, agricultural production is evaluated on a per acre basis. Labor and capital inputs will be considered at a later point.

[11] *Facts and Figures*, pp. 227-28, 235.

In evaluating the actual performance of the socialist sector, the contribution of the various agricultural sectors to national income can be of use. Table 4 shows the net product per acre in the state, collective, and private sectors in 1955 expressed in 1954 prices. The figures indicate the superiority of individual farming both in the category of crops (in general) and in livestock raising. As to the first, the productivity of the state sector was higher in cereals, but this was more than outweighed by the superiority of individual farming in intensive cultivation.[12] Individual farmers achieved these results at rather heavy odds. The socialist sector was given the advantage in the allotment of credits, in the apportionment of artificial fertilizers,[13] and in the allocation of machine work.[14] Other circumstances influencing productive activity on the private farm will be considered in the next section.

The Private Sector

If we wish to examine the impact of agricultural policy on the individual farmer, the following problems deserve consideration: the forced collectivization, the fight against the kulak, the planning of agricultural production, the system of compulsory delivery, and the so-called consolidation of holdings. These problems will now be taken up in turn.

Forced collectivization

The individual peasant could never be sure when a new campaign would compel him to join a collective farm. In view of this uncertainty, the farmer was reluctant to enlarge his productive activity. The peasant was especially unwilling to undertake investments, since he was afraid that their benefits would not be reaped by himself. It has been noted that "the peasants, fearful of collectivization . . . did not buy even the most important agricultural machines and tools."[15] Changes in the amounts spent on the means of production mirror the shifts and turns in the policy of collectivization. Available data show a steady decline in the proportion of the peasantry's income spent on means of production between

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[12] *Statistical Yearbook*, 1949-1955, p. 174.

[13] In 1956 the following quantities of artificial fertilizer were allotted to the various sectors (kilograms per hectare): state farms, 55.4; collective farms, 31.7; private farms, 4.2. *Monthly Bulletin of Statistics*, No. 1 (1957), 40.

[14] In 1956 approximately one-third of the agricultural machines belonged to the state farms (with 13 per cent of arable land), the remaining two-thirds were operated by the state-owned machine-stations. Some 24 per cent of machine work performed by these machine-stations was done for private farmers who worked 60 per cent of the arable land. *Monthly Bulletin of Statistics*, No. 1 (1957), 38-39. *Statistical Yearbook*, 1949-1955, pp. 154-57.

[15] S. Ausch and M. Gerö, "On the Danger of Inflation," *Közgazdasági Szemle*, Nos. 11-12 (1956), 1321.

TABLE 5. CHANGES IN AGRICULTURAL LAND LEFT FALLOW

Year	Hectares	Index
1949	43,806	100
1950	42,541	93
1951	48,563	111
1952	84,750	193
1953	62,107	142
1954	45,480	104
1955	67,240	153

Source: *Statistical Yearbook*, 1949–1955, p. 179.

1949 and 1953 from 17.2 to 10.2 per cent. In absolute figures, calculated on unchanged prices, the decrease per farmer was 39 per cent. The New Course brought about an improvement in 1954, but another decline took place in 1955.[16]

The impact of the policy of forced collectivization on the individual peasant can also be seen from changes in the area left fallow (Table 5). The data indicate a correlation between the intensity of collectivization and the area left fallow.[17] Both the increase in the fallow area and the reduction in the purchase of means of production show that the policy of forced collectivization interfered with productive activity on the individual farms.

Fight against the kulak

The Soviet example was imitated also in the fight against the kulak. In Hungary peasants possessing more than 13-14 hectares of land were considered kulaks. The most industrious part of the peasantry belonged to this group, the majority of whom acquired or increased their holdings by their own efforts. The kulaks employed one or two laborers and worked the land themselves. Their knowledge of efficient techniques of cultivation was considerably higher than that of the average peasant, and the surplus of their production over their own consumption needs constituted an important source of the agricultural products sold on the market. The number of kulaks in 1947 can be estimated at about 60 to 70 thousand; their land might have amounted to 20 or 21 per cent of the cultivated area.[18]

The fight against the kulaks was begun in 1948 and developed parallel

[16] F. Vági, "The Purchasing Power and the Commodity Supply of the Population," *A Magyar Tudományos Akadémia Közgazdaságtudományi Intézetének Évkönyve (Yearbook of the Economic Institute of the Hungarian Academy of Science)*, I. 1957. pp. 307-8.

[17] Similar conclusion is reached in *Facts and Figures*, p. 171.

[18] The author's estimate based on data published in the *Hungarian Statistical Handbook*, 1948.

to the drive for collectivization. The results of this campaign can be seen in changes in livestock in the hands of the kulak and in their landholdings. Faced with confiscation, the kulaks disposed of most of their livestock. Data on a sample consisting of 600 kulak farms show that in 1949 the number of cattle and horses per farm was 4.6, against 14.9 in 1935.[19] During the period 1950-53, the restriction of the kulak often gave place to his liquidation, and the number of kulak holdings decreased by one-third, while their arable land diminished by two-thirds.[20] These circumstances contributed to the increase in fallow land noted above: because of uncertainty in agriculture, a considerable part of these lands remained uncultivated.

The New Course resulted in an easing of the situation. In 1954, however, voices were raised against the too lenient policy toward the kulak. Rákosi announced that while prior to 1953 "the right policy of the restriction of the kulak frequently slid into the liquidation of the kulak, since last [1953] June the opposite extreme has been experienced in several places: the fight against the kulak is barely continued, and the kulak is treated like a middle peasant."[21] After the repudiation of the New Course the strengthening of the class war against the kulak came to the foreground again.[22]

In considering the economic effects of this policy, besides the loss in production due to the decline in kulak holdings, its impact on the middle peasant should be emphasized. The so-called kulak limit was highly flexible. Because of general policy changes or a change in the person of the district party secretary some people were requalified several times as middle peasants only to have the kulak tag pinned on them again a year later. Instead of the official limit of 14.3 hectares (and there were many exceptions to this limit), frequently peasants possessing 9 to 10 hectares were put on the kulak list. Consequently, the middle peasant could not feel himself removed from the danger of being classified as kulak. This uncertainty was reinforced on the official side as well. Rákosi admonished that "if the middle peasant becomes a kulak, the regulations on the restriction of the kulak will become applicable against him."[23] This policy has certainly discouraged the middle peasant from developing his productive activity.

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[19] A Mód, "The Kulak-question in the Mirror of Statistics," *Statisztikai Szemle (Statistical Review)* No. 12 (1949), p. 397.

[20] *Gazdasági életünk egyes kérdései a közgazdaságtudomany tükrében (Some Problems of Our Economic Life in the Mirror of Economic Science)* (Budapest, 1954), p. 411. (Hereinafter cited as *Some Problems.)*

[21] *Szabad Nép,* May 25, 1954. Those farmers were considered middle peasants who owned more than 5-6 hectares but not more than 13-14.

[22] Editorial in the *Társadalmi Szemle (Social Review),* Nos. 2-3 (1955), 7, and *Szabad Nép,* February 27, 1955.

[23] *Szabad Nép,* May 25, 1954.

Planning of agricultural production

Detailed planning in agriculture also has considerably affected the individual peasant. The sown area of various crops was planned for the whole country as well as on county, district, and village levels.[24] On the basis of these plans, individual peasants were compelled to devote certain portions of their holdings to the production of various cereals, sunflower, and—for some years—cotton. The compulsory sowing of cotton on individual farms was part of the drive for autarky when an attempt was made to acclimate cotton, natural rubber, peanuts, and other hitherto uncultivated industrial crops in Hungary. The Five Year Plan (1950-54) prescribed that "measures have to be taken that the raw-material demands of the Hungarian textile industry should be satisfied to a larger extent by home-grown cotton. It is to be endeavored that by the last year of the Plan period 100,000 hold should be planted with cotton."[25] The failure of cotton cultivation resulted in losses for both the individual peasant and the national economy.[26] Aside from the mandatory cultivation of cotton, economical production suffered also from the percentage allotments of the planting of several other crops, for the possibility of specilization was diminished thereby and some crops were sown even if the soil was more suitable for other produce.

System of compulsory delivery

Another method for ensuring cultivation of certain crops was compulsory delivery. The relative importance of this method for particular crops can be seen in Table 6. The figures indicate that the relative weight of compulsory delivery changed with revisions of agricultural policy. In general, at the end of the period the compulsory delivery obligations had

TABLE 6. COMPULSORY DELIVERY OF SELECTED AGRICULTURAL PRODUCTS AS PERCENTAGE OF PRODUCTION

	1950	1951	1952	1953	1954	1955
Wheat	42.6	45.6	56.0	50.0	47.0	54.4
Rye	49.3	47.2	55.0	51.8	43.7	57.5
Bread grains	44.4	46.0	55.7	50.3	46.3	55.0
Barley	21.6	27.4	41.8	28.5	24.5	20.3
Corn	9.4	16.1	23.2	13.5	12.6	15.5
Potatoes	16.5	17.0	27.9	17.3	17.8	20.7

Source: *Statistical Yearbook*, 1949–1955, p. 234.

[24] *Some Problems*, p. 126.

[25] *The Five Year Plan of the Hungarian People's Republic*, Budapest, 1950, p. 33. One hold = 0.576 hectares = 1.42 acres.

[26] Due to the disheartening results, only 725 hectares of cotton were sowed in 1955. Harvest was practically nil. *Statistical Yearbook*, 1949-1955, p. 174; *Monthly Bulletin of Statistics*, No. 5 (1957), 73.

a higher share in production than in 1950. The situation is similar with regard to pigs and dairy products, including poultry and eggs. If the peasants' own consumption is taken into account, not much remained for the free market after the compulsory delivery obligations had been satisfied. (The share of the peasantry in food consumption may correspond to its relative share in the population—44 per cent at the end of the period.)

As compulsory delivery obligations increased, there was an increasing divergence between delivery and free market prices. On 1949 basis, by 1955 prices paid for compulsory delivery had increased by 13 per cent, prices paid by the state for purchases outside the compulsory delivery system had risen by 110 per cent, whereas free market prices showed a 234 per cent increase. The average increase in the prices of agricultural produce was 144 per cent.[27] In examining the effects of the compulsory delivery system, the following considerations are of importance:

1. The existence of the compulsory delivery system had a psychological effect on the peasantry. Most of the farmers were not aware that if this system had been abolished, their income might have remained unchanged if calculated on the newly established average prices. Rather, the comparison was made with existing free market prices, and the farmers concluded that the state, through low delivery prices, had curtailed their income. It has been contended that such considerations are likely to have impeded the development of agricultural production.[28]

2. The wide discrepancies between state and free market prices magnified the fluctuations of the peasantry's income: in bad years nothing remained for sale on the free market after compulsory delivery obligations had been fulfilled, whereas in good years the earnings were extremely high. Official data show that, for example, the real income of the peasantry decreased by 56 per cent between 1951 and 1952 and rose again by 63 per cent between 1952 and 1953.[29]

3. The high delivery quotas left little possibility for the farmer to adjust his production according to the conditions of his soil.

4. The steeply progressive delivery quotas endangered the viability of medium and kulak farms.

In view of these considerations, the impact of the compulsory delivery system seems to have been disadvantageous for economical production in agriculture. During the Revolution, compulsory delivery obligations were abolished, and the new Communist government has not reinstated this unpopular system. Nevertheless, a land tax was levied in kind, and

[27] *Áralakulás Magyarországon 1938-ban és 1949-1955-ben (Prices in Hungary in 1938 and in 1949-1955)*, Central Statistical Bureau, Budapest, 1957. p. 7.

[28] K. Szabó, "The Role of the Free Market in the New Course," *Társadalmi Szemle*, Nos. 8-9 (1954), 44.

[29] *Statistical Yearbook* 1949-1955, p. 296.

threshing fees also have to be paid in kind to the state machine stations.[30]

Land consolidation

The situation of the individual farmers was also greatly affected by the so-called land consolidation. It was intended to consolidate the holdings of state and collective farms by regrouping their land in one piece. Land consolidation did not mean exchange of land plots for land of identical quality; rather, the authorities gave the better lands to the socialist sector, at the expense of the individual farmer. This policy was also used to compel the individual peasant to enter the collective farms. Official statistical data based on a sample comprising four counties show that in exchange for their original holdings, the private farmers received land of lower quality and at a greater distance from their domicile.[31] In many districts land plots were regrouped again and again in succeeding years. The extent of land consolidation can be seen if the areas affected by the land reform of 1945 and by the regroupings of 1949-56 are compared. In the former case, 3.2 million hectares were redistributed, in the latter case 5.2 million hectares—almost 60 per cent of agricultural land—were regrouped.[32]

It has been said that the "regrouping and particularly the absence of compensation considerably reduced the will to produce on the part of the individual peasants."[33] Because of the danger of regrouping the individual farmer was not only disinclined to make investments but also reluctant to use the necessary quantity of fertilizer on his land. The data of Table 7 supply evidence of the impact of land consolidation on productivity, indicating a high correlation between the intensivity of regrouping and the change in the yield of wheat production. Changes in livestock were similarly correlated with land consolidation. In counties with extensive regrouping the number of livestock decreased by 8 per cent in the above period; in the case of little regrouping the reduction was only one per cent; whereas in counties where regrouping of land did not occur at all livestock increased by 12 per cent.[34]

In addition to the factors mentioned above, production on private farms was influenced also by imposition of high taxes, unavailability of credits,

[30] *Népszabadság (Freedom of the People)*, April 6, 1957, and *Szabad Föld (Free Land)*, March 24, 1957.

[31] The reduction in quality (expressed in net income equivalent) was, on the average, 15 per cent, whereas the distance from the domicile rose by 42 per cent. L. Borbély, "The Role of the 1949-55 Land-Regroupings of Farm Plots and Their Impact on Our Agriculture," *Statisztikai Szemle*, No. 6 (1957), 456.

[32] *Ibid.*, p. 452.

[33] *Ibid.*, p. 457.

[34] *Ibid.*, p. 453.

TABLE 7. LAND CONSOLIDATION AND PRODUCTIVITY

Proportion of Regrouped Area in Total Agricultural Area of Counties	Yield of Wheat Production in 1953–55 as a Percentage of the Yield in 1949–52
30– 40	114
40– 50	106
50– 60	102
60– 80	98
80–100	94
Average	102

Source: L. Borbély, "The Role of the 1949–55 Regroupings of Farm Plots and Their Impact on Our Agriculture," *Statisztikai Szemle*, No. 6 (1957), 452.

and neglect of the individual farmer's fertilizer and machine needs, as mentioned in the previous section.

Production Results in Hungarian Agriculture

In the foregoing sections we have examined the effects of the agricultural policy on various groups of producers. We shall now turn to the actual production results of Hungarian agriculture.[35] We intend to rely primarily on physical data, since estimation of the net contribution of agriculture to national income is greatly influenced by the choice of price-weights and by the methods employed in the calculation of the value of materials used up in agriculture. Nevertheless, physical data have deficiencies of their own in regard to harvest estimates and livestock figures.[36]

We begin with a comparison of the employment of land in various uses

TABLE 8. USE OF LAND IN HUNGARY

	1935	1956	1935	1956
	1000 Hectares		*Percentage*	
Arable land	5,606	5,400	60.3	58.0
Gardens, vineyards	321	368	3.4	3.9
Meadows, pastures	1,646	1,452	17.7	15.6
Forest	1,132	1,291	12.1	13.9
Productive land	8,705	8,511	93.5	91.4
Nonproductive land	604	801	6.5	8.6
Total	9,309	9,312	100.0	100.0

Source: A. Kiss, "Changes in Intensive Cultivation during the Last Hundred Years, 1857–1957," *Statisztikai Szemle*, Nos. 1–2 (1958), 28–29.

[35] With regard to agricultural production, the production results up to 1956 will be taken into account since the harvest was gathered before the outbreak of the Revolution.

[36] On problems of harvest estimates in Hungary and other eastern European countries see *Economic Survey of Europe in 1951*, U.N. Economic Commission of Europe. Geneva, 1952, pp. 222-25. On the quality of livestock cf. below.

TABLE 9. SOWN AREAS, YIELDS AND HARVESTS

	1911–15	1936–40	1952–56
Bread grains			
Area (million hectares)	2.23	2.21	1.83
Yield (quintals per hectare)	12.5	13.7	13.3
Harvest (10 million quintals)	2.79	3.01	2.44
Coarse grains			
Area (million hectares)	1.78	1.87	1.72
Yield (quintals per hectare)	15.1	18.4	17.8
Harvest (10 million quintals)	2.66	3.44	3.06
Potatoes			
Area (million hectares)	0.246	0.288	0.222
Yield (quintals per hectare)	80.1	81.0	85.7
Harvest (10 million quintals)	1.94	2.31	1.91
Sugar beets			
Area (million hectares)	0.060	0.049	0.114
Yield (quintals per hectare)	248.5	212.0	174.4
Harvest (10 million quintals)	1.50	1.04	1.99

Source: Data for 1911–15 and 1936–40 are from *Economic Bulletin for Europe* (August 1955), p. 92. Data for 1952–55 are from *Statistical Yearbook* 1949–1955, pp. 171–76 and for 1956 from *Monthly Bulletin of Statistics*, No. 1 (1957), 32–33. It should be noted that the total area of the crops under consideration amounted to about 75 per cent of total arable land in the examined periods.

before the war and at the end of the period under consideration (Table 8). It appears that the reduction in arable land and in meadows and pastures has been due to the disincentive effects of various measures described in the foregoing sections. Other things being equal, these reductions lessened the available quantity of food products partly directly, partly indirectly through their impact on livestock raising. The favorable increase in the area of gardens and vineyards (actually there has been a small reduction in vineyards and a large increase in gardens) is likely to be primarily the consequence of the land reform.

Table 9 presents a comparison between sown areas, yields, and harvests of the main crops in the periods 1911-15, 1936-40, and 1952-56. If compared to the 1936-40 period, a deterioration in yields is apparent in bread grains, coarse grains, and sugar beets, whereas potato yields show an

TABLE 10. HARVESTS PER HEAD OF THE POPULATION

	1911–15	1936–40	1952–56
	Kilograms	*Kilograms*	*Kilograms*
Bread grains	356	328	251
Coarse grains	350	375	316
Potatoes	248	252	199
Sugar beets	191	113	204

Source: Population figures for 1911–15 are from *Annuaire Statistique Hongrois* (1938), p. 1; for 1936–40 and 1952–55 from *Statistical Yearbook*, 1949–1955, p. 3; and for 1956 in *Monthly Bulletin of Statistics*, No. 1 (1957), 3.

TABLE 11. YIELDS OF BREAD GRAINS IN VARIOUS COUNTRIES

	Wheat			Rye		
	1934–38	1951–55	Index	1934–38	1951–55	Index
	Quintals per hectare		*1934–38=100*	*Quintals per hectare*		*1934–38=100*
Denmark	30.4	37.5	124	17.7	24.9	141
Netherlands	30.2	37.7	124	22.8	28.2	124
Belgium	26.9	33.4	124	24.0	27.8	116
England	23.1	29.2	126	16.2	22.8	141
West Germany	22.0	27.6	125	18.4	24.2	131
Hungary	14.0	13.9[1]	99	11.5	11.4[1]	99

[1] 1952–56.

Source: Data are from B. Csendes, "The Development of the Production of Bread Grains in Hungary before and after the Liberation," *Yearbook of the Economic Institute . . .*, p. 360, except for Hungary, for which the 1934–38 data are from *Annuaire Statistique Hongrois* (1938), p. 88, and the postwar figures (in the case of Hungary referring to the 1952–56 period) are taken from sources of Table 9.

improvement. The sown area has been reduced for bread grains, coarse grains, and potatoes and increased for sugar beets. The absolute decrease in the harvest of bread and coarse grains and of potatoes appears to be considerable. The discrepancies are magnified if the harvests of different periods are reckoned per capita of the population. The data of Table 10 indicate that in regard to harvest per capita the last period scores worse by comparison not only with 1936-40 but also with 1911-15, the exception being sugar.

Harvest figures show the availability of certain crops; in the evaluation of productivity of crop cultivation a comparison of changes in yields in various countries can be of use. The data of Table 11 show parallel increases of yields in various West European countries and a widening gap in yields between these countries and Hungary. Similar discrepancies can be observed also with regard to barley, corn, potatoes, and sugar beets.[37] It becomes apparent that the relative position of Hungarian crop cultivation has greatly deteriorated during the postwar period.

The formerly noted decrease in the area of meadows and pastures taken together applies also separately to each. Whereas in 1938 the area of meadows was 645 and that of pastures 965 thousand hectares, the corresponding figures for 1955 are 560 and 913 thousand hectares. The data available on the yield of the meadows show a decrease from 28.4 quintals of hay per hectare in 1938 to 25.0 quintals in 1955.[38] These changes, alongside the reduction in the available quantity of coarse grains indicate a shrinkage in the fodder base of animal husbandry.

[37] K. Garamvölgyi, "Problems of Planned Development in Agriculture," *Közgazdasagi Szemle*, No. 5 (1957), 537.

[38] Data for 1938 are from *Annuaire Statistique Hongrois* (1938), pp. 82, 93; for 1955 from *Statistical Yearbook*, 1949-1955, p. 180.

TABLE 12. LIVESTOCK IN THE PREWAR AND POSTWAR PERIOD

Date	Cattle	Cows	Hogs	Sows	Horses	Sheep	Poultry
			Thousand Head				
1938, March 1	1,882	917	5,224	602[1]	886[1]	1,629	21,919[1]
1950, Feb. 20	2,222	1,064	5,542	638	712	1,049	—
1956, March 1	2,170	891	6,056	479	729	1,930	22,779
			Per 1000 Inhabitants				
1938, March 1	204	99	568	66[1]	98[1]	177	2,432[1]
1950, Feb. 20	237	113	591	67	75	112	—
1956, March 1	218	91	608	48	73	194	2,280

[1] February 28, 1935.

Source: For 1938, *A Magyar Gazdaságkutató Intézet Helyzetjelentései* (*Economic Reports of the Hungarian Institute for Economic Research*) No. 44 (1939), 83; for 1935, 1950, and 1956, *Statistical Yearbook, 1949–1955*, p. 184. There are no data on the stock of poultry in 1950.

Changes in the quantity of livestock can be seen from Table 12. The figures indicate that animal husbandry made great strides in the years following the land reform of 1945. Yet after the collectivization campaign began, the number of cattle decreased; and the sharp fall in the number of cows and sows does not augur well for future reproduction either. With regard to cattle, hogs, and sheep, the 1956 figures compare favorably with prewar data. Nevertheless, it has been reported that the quality of livestock was considerably lower in 1956 than during the thirties. Whereas in 1930-35 the average weight of slaughtered cattle was 469 kilograms, it decreased to 410 kilograms by 1954 and to 408 by 1955. In the same years, the average weight of slaughtered calves declined from 73 kilograms to 59 and finally to 57.[39] Similar changes are said to have occurred in regard to pigs.[40] In the case of sheep—in spite of the 18 per cent increase in stock—wool production declined by 30 per cent between 1938 and 1955.[41]

It is likely that the main causes for unfavorable developments in animal husbandry are the policies examined in the foregoing sections and the insufficient fodder base of livestock raising. These deficiencies resulted, on the one hand, in a shift of the composition of the diet from animal to vegetable foods,[42] and, on the other hand, in the deterioration of export possibilities for Hungarian animal husbandry.[43] Frequent shortages in meat, lard, and dairy products have been experienced during recent

[39] *Facts and Figures*, p. 257.

[40] M. Ribianszky, "On the Agricultural Program," *Agrártudomány* (*Agrarian Science*), Nos. 1-2 (1957), 3.

[41] Garamvölgyi, *op. cit.*, p. 539.

[42] D. Kovács, "Food Consumption in Hungary in the Years 1950-55," *Közgazdasági Szemle*, No. 1 (1958), 91-93.

[43] Whereas in 1938 17.4 per cent of Hungarian exports were livestock-export, this percentage decreased to 6.7 per cent in 1949 and 2.9 per cent in 1955. *Annuaire Statistique Hongrois* (1938), pp. 156-57 and *Statistical Yearbook*, 1949-1955, pp. 256-57.

TABLE 13. THE CONTRIBUTION OF AGRICULTURE TO NATIONAL INCOME

Year	Index of the Net Value of Agricultural Production	
	1938=100	1949=100
1938	100	—
1949	84	100
1950	94	112
1951	112	137
1952	70	83
1953	97	115
1954	92	110
1955	107	127
1956	88	106

Source: *National Accounts*, p. 100.

years.[44] According to official data, per capita meat consumption was 41.4 kilograms in 1935 and only 35.9 in the especially good agricultural year 1955. If the years 1950-52 and 1953-55 are compared, the corresponding figures are 34.6 and 32.5.[45] The consumption of milk and dairy products presents a similar picture; whereas in 1934-38 the average yearly consumption of these products was 102 kilograms per inhabitant in milk equivalents, the corresponding figure for 1950-55 was 92.7. During the latter period, consumption per head amounted to 112 kilograms in 1950 and 87 in 1955.[46]

We mentioned previously that the contribution of agriculture to national income is influenced by the choice of price weights and by the methods used in estimating the value of materials used up in production. In the absence of relevant information on these methods we present the official figures here. The figures of Table 13 indicate the inferior performance of Hungarian agriculture when compared to prewar production. The improvement between 1949 and 1956 is not impressive if we take into consideration that in 1949 the after-effects of the Second World War were still noticeable. It should be noted here that the reduction in the net value of agricultural production between 1938 and 1956 entails a deterioration of efficiency in view of the fact that the slight reduction in labor inputs[47] appears to be more than counterbalanced by the increase in capital inputs.[48]

[44] Kovács, p. 100.

[45] I. Szlamenszky, "The Main Economic Aspects of the Hungarian Poultry and Egg Production," *Közgazdasági Szemle*, Nos. 11-12 (1956), 1374.

[46] Kovács, p. 91.

[47] Taking changes in the agricultural population representative for changes in the agricultural working force, and assuming unchanged labor hours, the reduction in labor inputs may amount to 2 per cent in the above period. (*National Accounts*, p. 9)

[48] Official data show that, measured in 1000 HP, the stock of agricultural machines

Summary

Our findings indicate the impact of agricultural policy on the production results of Hungarian agriculture. It appears that policy decisions were primarily responsible for the lack of development in the direction of intensive cultivation. At the same time, the newly established state and collective farms, the activity of which focused on extensive crops, showed less than satisfactory results. On the other hand, various measures such as the forced collectivization campaign, the fight against the kulak, the high delivery quotas, land consolidation, etc., restrained productive activity on private farms. In the face of the postwar agricultural developments abroad, these measures have brought about a widening of the gap between the agriculture of Western European countries and that of Hungary, and also a deterioration in yields of various crops. In addition, unfavorable developments in livestock raising have required a change in the composition of the diet at the expense of animal foods, and necessitated a curtailing of livestock exports. Official data reveal also a decrease in the net value of agricultural production if compared to the prewar period, indicating a deterioration of efficiency in view of the fact that, taken together, there has been some increase in labor and capital inputs.

increased from 611.9 to 858.9 between 1935 and 1957. (A. Kiss, "Changes in Intensive Cultivation during the Last Hundred Years, 1857-1957," *Statisztikai Szemle*, Nos. 1-2 (1958), 28-29.)

REGIONAL DIFFERENCES IN FACTOR SHARES IN AMERICAN AGRICULTURE: 1925-1957*

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DIFFERENCES in the functional distribution of income, both over time and between sectors or regions, are of considerable theoretical and empirical interest. For example, in a situation characterized by competitive equilibrium and homogeneous production functions, the relative share of total income allocated to the several factors of production can be interpreted as productivity coefficients.[1] If the assumptions of competitive equilibrium and homogeneous production functions are considered to be too unrealistic, factor share ratios still have considerable empirical relevance as indicators of the extent to which the several factors of production share in the distribution of output and how this share has changed over time.[2,3]

In this paper, factor share data on both a net and a gross basis is pre-

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Basic data from which the tables included in this paper were derived have been compiled in an appendix, not here included, that the authors will be glad to furnish upon request.

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[1] Durand, D., "Some Thoughts on Marginal Productivity, With Special Reference to Professor Douglas' Analysis," *J. Pol. Econ.*, 45:742 (Dec. 1937); Robinson, Joan, *The Economics of Imperfect Competition* (London: Macmillan and Co., Ltd., 1948), pp. 241-242; Stigler, G., "Euler's Theorem and the Marginal Productivity Theory," *Production and Distribution Theories* (New York: The Macmillan Co., 1941), pp. 320-387.

[2] This has been the major concern of most investigators of factor shares in the past. See, for example, Hahn, F. H., "The Share of Wages in the National Income," *Oxford Economic Papers*, 3:147-57 (June, 1951); Brown, E. H. Phelps, and P. E. Hart, "The Share of Wages in National Income," *Econ. Jour.*, 62:253-77 (June, 1952); Denison, Edward F., "Distribution of National Income," *Surv. Curr. Bus.*, 32:18 (June, 1952); Johnson, D. Gale, "The Functional Distribution of Income in the United States," *Rev. Econ. and Stat.*, 36:175-90 (May, 1954); Solow, R. M., "A Skeptical Note on the Constancy of Relative Shares," *Amer. Econ. Rev.*, 48:618-31 (Sept. 1958).

[3] For a defense of analysis based on "factor shares" in contrast to "productivity accounting," see Ruggles, Richard and Nancy, "The Conceptual Bases for the Measurement of Real Capital Stocks and Services." Paper presented at Conf. on Research on Income and Wealth, Nat. Bur. Econ. Res., New York, Oct. 17-18, 1958.

sented for five major agricultural regions of the United States for the period 1925-1955. These factor share data were developed as part of a research effort designed to identify the impact of technological change on resource requirements at both the national and regional levels.[4] In the past, most discussion of factor shares has been confined to national or industry aggregates with little or no attention to regional differences. The most complete analysis of factor shares in agriculture was presented by Gale Johnson in 1948.[5]

The main conclusions of Johnson's analysis were that for United States agriculture as a whole during the period 1910-14 to 1945-46: (1) Labor's share of total *net* agricultural income rose fairly steadily (from 58 to 65 per cent). As a share of gross agricultural income, it remained fairly stable at about 40 to 44 per cent between 1910-14 and 1935-39 but rose to close to 50 per cent by 1945-46. (2) The division of labor income between hired workers and operator families has been such that farm operators and their families received a lower return per person than hired workers in 21 out of the 37 years studied. Only after 1935 were labor returns consistently more favorable to operators. (3) The percentage share going to land has declined moderately. (4) The percentage share going to nonland capital has declined. (5) Current operating expenses and taxes showed no long-run tendency to either increase or decrease relative to net inputs (labor, land, and capital).

The trends in factor shares presented in this paper are in general agreement with the results reported by Johnson between 1910-14 and 1945-46 for United States agriculture as a whole. Since 1946, some of the earlier trends have apparently been reversed: (1) Labor's share has declined fairly steadily and is now below the level of the late 1920's. (2) In 1955, average returns to hired workers exceeded average returns to family workers for the first time since the mid-1930's. (3) The percentage share going to non-real-estate capital has risen since the mid-1940's. (4) The share going to land and to building has also risen since the mid-1940's. (5) Current operating expenses and taxes have risen sharply relative to net inputs.

A more detailed discussion of the regional differences in factor shares will be deferred until after a discussion of the assumptions and techniques employed in constructing factor share estimates for the several regions.

[4] See, for example, Stout, T. T., and V. W. Ruttan, "Regional Patterns of Technological Change in American Agriculture," *J. Farm Econ.*, 40:196-207 (May, 1958); Ruttan, "Agricultural and Nonagricultural Changes in Output Per Unit of Input," *J. Farm Econ.*, 39:1566-76 (Dec. 1957); Ruttan, "The Contribution of Technological Change to Farm Output, 1950-1975," *Rev. Econ. and Stat.*, 38:61-69 (Feb. 1956).

[5] Johnson, D. Gale, "Allocation of Agricultural Income," *J. Farm Econ.*, 30:724-45 (Nov. 1948).

Estimation of Factor Shares

Factor shares are estimated in this paper on both a net and a gross basis. Net income to agriculture is defined as the difference between total gross income and current operating expenditures and property taxes. Net income represents, therefore, the "value added" to agricultural output by the "primary" factors of production: capital, land, buildings, and labor. It is "net" to the agricultural sector of the economy rather than "net" to the farm firm.

Allocation of agricultural income among factors is subject to a number of difficulties. Many agricultural resources—particularly labor and land—do not receive a market return or have a market-determined price.[6] The methods used to deal with this and related problems are described below.

Total gross income

The U.S. Department of Agriculture "total gross income" series was employed as a measure of the total market value of commodities and services produced by farms. This series is not an ideal measure of the value of commodities and services produced by farms since it includes some double counting; interfarm sales of feed and seed, interstate sales of feeder and breeding livestock, and the value of inputs purchased from the non-farm sector which is of farm origin are all included in gross income.[7] While adjustments for most of these factors can be made at the national level, it was not possible to adjust the regional data.

Current operating expenses and taxes

This category includes expenditures for products or services purchased from nonagricultural industries for use in current production plus property (real-estate and non-real-estate) taxes. It also includes the items responsible for the "double counting" that occurs in the total gross income series. The measure of current operating expenses used in this paper differs from the U.S. Department of Agriculture series on total current farm operating expenses in that it does not include wages paid for hired labor.[8] When current operating expenses and taxes are subtracted from

[6] Johnson, D. Gale, "Allocation of Agricultural Income," *op. cit.;* Hurlburt, V. L., "Distribution of Income from Farm Land," *Land (The 1958 Yearbook of Agriculture)* (Washington: Govt. Print. Off., 1958), pp. 176-82; Scofield, W. H., "How Do You Put a Value on Land?" *ibid.*, pp. 183-89.

[7] The "total gross income" series is reported in the *Farm Income Situation.* The series is discussed in detail and United States data for 1910-1956 is reported in *Gross and Net Farm Income,* Agr. Handbook 118, vol. 3, U. S. Dept. Agr., Washington, Dec. 1957. Regional data for 1950-1957 is from the *Farm Income Situation.* Regional data for years prior to 1950 were derived from data provided by R. H. Masucci and Q. F. Dallavalle, Farm Income Branch, U. S. Dept. Agr.

[8] The series, "Current Farm Operating Expenses," and its major components is re-

total gross income, a measure of the "value added" to the national product by agriculture is obtained that is comparable to the estimates included in the Department of Commerce estimates of Gross National Product. To obtain an estimate comparable to the Net National Product concept, it would be necessary to make a further reduction for capital consumption or depreciation.

Non-real-estate capital

The share of income allocated to non-real-estate capital was obtained by multiplying the estimated current value of capital by the average annual interest rate paid on non-real-estate loans held by commercial banks and federal agencies in each region and adding to this the annual depreciation on non-real-estate capital equipment.[9] Non-real-estate capital was defined to include all productive non-real-estate physical assets, including tractors, 40 per cent of the value of automobiles, other machinery and equipment, and livestock and crop inventories. It does not include land, buildings, household furnishings, or financial assets.[10] This is somewhat different from Johnson's treatment. Johnson classified depreciation as a production cost, along with property taxes and products and services purchased from the nonfarm sector for use in current production. It seemed more reasonable to allocate sufficient income to capital to cover both capital consumption, as measured by depreciation, and opportunity costs, as measured by imputed interest charges.

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ported in the *Farm Income Situation*. The series is discussed in detail, and U. S. data for 1910-1956 are reported in *Gross and Net Farm Income, op. cit.* Regional data for 1950-1957 are from the *Farm Income Situation*. Regional data for years prior to 1950 were provided by R. H. Masucci and Q. F. Dallavalle, Farm Income Branch, U. S. Dept. Agr.

[9] The national and regional estimates of depreciation are Farm Income Branch estimates of depreciation of motor vehicles and other machinery and equipment. This series is discussd in detail and U. S. data for 1910-1956 are reported in *Gross and Net Farm Income, op. cit.* Regional estimates are from unpublished data in the Farm Income Branch files. The national and regional estimates of the value of capital in current dollars for census years are from Tostlebe, Alvin S., *The Growth of Physical Capital in Agriculture, 1870-1950,* Occas. Paper 44, Natl. Bur. Econ. Res., 1953. For noncensus years it was necessary to use interpolations based on the depreciation estimates referred to above. The national and regional interest rates used in computing the return on capital for the period 1925-1935 are from Lingard, H. T., and W. O. Brown, "Interest Charges Payable on Farm Indebtedness in the United States, 1910-1950," U. S. Bur. Agr. Econ., Aug. 1952. For the years 1936-1957, unpublished data were provided by F. L. Garlock of the Agr. Finance Sect., U. S. Agr. Res. Serv.

[10] The question of how to treat financial assets, which represent approximately 5 per cent of agricultural assets, poses several difficulties. Due to mixture of household and firm accounts, the extent to which financial assets of farmers represent working capital of the farm firm or personal savings of the farm family is not always clear. If working capital is included, an argument can be made for treating it as an element of current operating expenses rather than as part of non-real-estate capital.

Perhaps the major question that can be raised regarding the estimates of the factor share going to non-real-estate capital deals with the effect of depreciation techniques on capital stock estimates. Griliches has recently pointed out that estimates of the value of the stock of capital on farms are quite sensitive to changes in the methods and rates of depreciation used. For example, use of a straight-line depreciation method rather than the declining balance method currently used by the U. S. Department of Agriculture resulted in twice as large an estimate of value of the stock of tractors in 1940.[11] Combining the return on non-real-estate capital and capital consumption into one measure of the factor share going to capital minimizes the error resulting from inappropriate depreciation techniques since underestimates of capital value are, in part, offset by overestimates of depreciation. It seems possible, however, that some underestimation of the factor share going to non-real-estate capital still remains.

Buildings

The same general procedures were followed in estimating the share of income allocated to buildings as in estimating the share allocated to non-real-estate capital. The current value of farm buildings was multiplied by the average rate of interest charged on farm mortgage debt outstanding in each region. This figure was then combined with an estimate of the depreciation on farm buildings.[12]

The question might be raised as to why buildings were treated separately rather than combined with land or with non-real-estate capital items. Buildings were treated separately because of the considerable ambiguity associated with investment in buildings. The Department of Agriculture includes in its farm income estimate the imputed rental value of farm dwellings. As an offset, depreciation on farm dwellings is included as a production expense. Although it might have been better to exclude

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[11] Griliches, Zvi, "Output Over Input Indexes and the Measurement of Technological Change," U. of Chicago Off. of Agr. Econ. Res., Paper No. 5819, Sept. 12, 1959.

[12] The national and regional estimates of building depreciation are the Farm Income Branch estimates of depreciation and accidental damage of farm operator's dwelling, service buildings, and other structures. This series is discussed in detail and data for 1910-1956 are reported in *Gross and Net Farm Income, op. cit.* Regional estimates are from unpublished data in the Farm Income Branch files.

National and regional estimates of the value of buildings for the years since 1940 were provided by W. H. Scofield, Farm Econ. Res. Div., U. S. Dept. Agr. These values are the same as those reported by Tostlebe, *op. cit.*, for census years. The Tostlebe estimates were used for the census years prior to 1940. For noncensus years prior to 1940, interpolations based on the depreciation estimates were used.

The national and regional interest rates were constructed from unpublished state data on average rates of interest charged on farm mortgage debt, supplied by J. A. Munger of the Agr. Finance Sect., U. S. Agr. Res. Serv.

the farm dwelling component from both sides, the procedure is justified by the Department of Agriculture on the basis that it is impossible to distinguish between rent paid for a farm as a business unit and rent paid for use of the dwelling by the farmer and his family. In view of these limitations, it is clear that any estimate of the value of farm buildings rests on extremely weak grounds.

Land

The share of income allocated to land was estimated by multiplying the value of land in each region by the average rate of interest charged on farm mortgage debt outstanding in each region in each year.[13]

This treatment is not quite symmetrical with the procedure adopted in the case of non-real-estate capital and buildings where a depreciation (or capital consumption) item is added to the return figure in computing the income allocated to the factor. Ideally, a figure representing depletion (or in some cases accretion) should be included in the land input category. Such a task would appear to be virtually impossible. It should be recognized, however, that the absence of any such adjustment may result in a differential bias in land input measures among regions and that part of capital investment and current operating expenditures represent expenditures designed to offset land depletion or to add to the productive capacity of land resources.

Perhaps an even greater source of potential bias is the method of valuing grazing land not in farms in the Mountain and Pacific regions where, in contrast to the other regions, grazing land not in farms represents a fairly substantial share of the total land used for agricultural purposes. In Table 1, Estimate A represents the share of total gross farm income allocated to land when grazing land not in farms is valued the same as dryland grazing land in farms. Estimate B represents the share when grazing land not in farms is omitted as a component of land inputs. The initial decision to combine the value of grazing land not in farms with the value of land in farms (in the form indicated in Estimate A) to arrive at a measure of the total value of land in current dollars for the Mountain and Pacific regions was based on two considerations: (1) It is fairly generally accepted

[13] The annual estimates of the value of land in current dollars were provided by W. H. Scofield, Farm Econ. Res. Div., U. S. Dept. Agr. The values are the same as those reported by Tostlebe, *op. cit.*, for census years. In the Mountain and Pacific regions, the Scofield-Tostlebe estimates were adjusted upward by adding the estimated value of dryland grazing land not in farms. The value of dryland grazing land not in farms was computed by multiplying the acres of grazing land not in farms by the estimated price per acre of dryland grazing land in farms. Data on the price of dryland grazing land in farms were provided by Scofield.

TABLE 1. ALTERNATIVE FACTOR SHARE ESTIMATES FOR LAND IN THE MOUNTAIN AND PACIFIC REGIONS (GROSS INCOME BASIS)*

Year	United States		Mountain region		Pacific region	
	A	B	A	B	A	B
	per cent					
1957	12.4	11.6	19.9	14.1	19.1	15.4
1956	11.6	10.8	21.1	14.9	17.0	13.7
1955	11.5	10.5	21.4	15.0	17.0	13.5
1954	10.6	9.7	20.6	14.3	16.4	12.8
1953	10.5	9.6	19.5	13.3	16.2	12.4
1952	9.4	8.8	16.3	11.0	14.4	10.9
1951	8.3	7.9	13.6	9.1	12.4	9.2
1950	8.1	7.4	14.0	9.3	12.6	9.2
1949	8.8	8.1	16.1	10.8	14.1	10.5
1948	7.3	6.7	13.9	9.3	14.2	9.8
1947	7.5	7.0	13.3	9.0	13.1	10.0
1946	7.5	6.9	14.9	10.1	12.4	9.7
1945	7.5	6.9	14.2	9.7	11.7	9.3
1944	6.8	6.3	12.9	8.4	10.5	8.1
1943	6.1	5.6	11.1	6.9	9.2	6.9
1942	6.4	5.9	12.0	7.2	10.6	7.7
1941	8.4	7.2	14.4	8.2	13.3	9.5
1940	10.4	9.4	18.4	10.1	17.1	11.9
1939	11.3	9.1	20.2	11.0	20.0	13.9
1938	12.0	10.9	21.7	11.5	21.6	14.7
1937	10.7	9.7	23.7	12.5	20.5	13.9
1936	13.2	11.8	22.2	11.5	19.6	13.2
1935	13.5	12.2	24.5	12.6	22.0	14.7
1934	18.7	17.1	35.7	18.1	25.2	16.6
1933	20.9	19.0	40.9	20.8	33.0	21.6
1932	28.4	25.7	54.6	27.8	50.2	33.1
1931	24.8	22.3	57.0	29.0	46.5	30.4
1930	21.1	18.9	45.2	22.5	41.9	27.0
1929	17.2	15.4	35.1	17.2	34.7	22.2
1928	17.6	14.6	32.3	15.6	34.7	21.9
1927	18.6	16.7	31.9	15.3	37.2	23.4
1926	19.3	18.3	37.2	17.6	38.9	24.3
1925	18.9	17.0	37.2	17.4	37.2	23.0

* Estimate A represents the share of total gross (farm) income allocated to land by the procedure outlined in footnote 13 when grazing land not in farms is valued the same as dryland grazing land in farms. Estimate B represents the share when grazing land not in farms is omitted as a component of land input.

that fees charged for grazing privileges by the Bureau of Land Management have traditionally understated the value of forage production on public grazing lands.[14] (2) The acres of grazing land not in farms in the two regions have not remained stable but have declined relative to the

[14] For an excellent documentation of this point, see Gardner, B. D., "The Pricing of Livestock Forage on Federal Range Lands," Paper presented at the annual meeting of the Western Agr. Econ. Res. Council, Range Comm. meeting, Pullman, Wash., Aug. 1958. See also Phillip O. Foss, "The Determination of Grazing Fees on Federally-Owned Range Lands," *J. Farm Econ.*, 41:535-47, (Aug. 1959).

acres of grazing land in farms.[15] Adjusting the value of land upward by the value of grazing land not in farms can result in an overestimation of the share of income which should be allocated to land if the difference between the value of forage production on public lands and grazing fees charged for the privilege of using public land becomes capitalized into the value of land owned by holders of grazing permits.

The discrepancy between the two factor share estimates has declined from approximately 20 percentage points in the Mountain region and 10 to 15 percentage points in the Pacific region during the late 1920's to approximately 5 percentage points in both regions in recent years (Table 1). The improvement in the residual labor return estimates (see Table 2 below) which results from use of Estimate B rather than Estimate A as the factor share estimate for land would seem to indicate that use of Estimate A does overestimate the share of income that should be allocated to land. No clear-cut explanation of this convergence is available. It seems unlikely that either increases in grazing fees or reduction in acreage grazed under forest service permits has been of sufficient importance to bring about the observed convergence.

Labor

Two alternative procedures were adopted in estimating the share of income to be allocated to labor. The *first* (Estimates A and B in Table 2) was to assign to labor the residual share remaining after the computed shares for current inputs and taxes, capital, buildings, and land had been subtracted from total gross income. If it could be assumed that the prices of current inputs and the rate of interest on non-real-estate capital and on real estate accurately reflected the marginal productivity of these factors and that depreciation charges accurately reflected use rates, this procedure could be used with considerable confidence. It is perfectly clear,

[15] The following changes took place between 1930 and 1954:

PASTURE AND RANGE LAND IN FARMS AND NOT IN FARMS IN TWO WESTERN REGIONS

Year	Mountain			Pacific		
	Total	In farms	Not in farms	Total	In farms	Not in farms
1930						
Thousand acres	445,143	121,392	323,751	122,917	37,611	85,306
Percent	100	27.3	72.7	100	30.6	69.4
1954						
Thousand acres	429,724	218,107	211,617	105,868	49,524	56,341
Percent	100	50.8	49.2	100	46.8	53.2

Source: Wooten, H. H., and J. R. Anderson, *Major Land Uses in the United States*, U. S. Dept. Agr. Inf. Bull. 168, Jan. 1957, p. 98.

TABLE 2. FACTOR SHARE ESTIMATES FOR LABOR BY REGION AND BY TYPE OF ESTIMATE (GROSS INCOME BASIS)*

Year	United States			Northeast		North Central		South		Mountain			Pacific		
	A	B	C	A	C	A	C	A	C	A	B	C	A	B	C
	per cent														
1957	23.3	24.1	24.4	19.4	25.0	21.8	22.7	25.8	26.9	17.8	23.6	21.7	28.1	31.8	26.0
1956	25.2	26.0	25.0	23.9	25.0	20.8	24.5	31.3	27.8	14.0	20.2	23.4	32.5	35.8	25.8
1955	25.8	26.8	26.5	24.5	25.0	20.5	25.8	33.7	28.2	14.5	20.9	24.1	32.4	35.9	26.2
1954	28.7	29.6	26.2	24.9	25.7	28.6	24.2	31.5	29.6	16.7	23.0	24.0	32.7	36.3	26.5
1953	29.8	30.7	27.5	29.9	24.5	26.7	25.8	35.1	31.2	21.1	27.3	24.0	34.0	37.8	27.6
1952	32.7	33.3	25.7	31.0	22.6	29.9	23.2	36.4	30.8	26.5	31.8	21.8	36.7	40.2	26.9
1951	36.6	37.0	25.1	32.5	22.7	33.3	22.3	42.6	30.3	32.2	36.7	19.9	38.8	42.0	26.7
1950	37.4	38.0	26.1	32.5	24.5	35.4	22.9	42.8	30.9	30.3	35.0	23.0	38.0	41.4	28.7
1949	37.2	38.9	29.7	34.4	25.0	33.5	26.6	45.1	34.6	28.4	33.7	27.2	37.1	40.7	33.8
1948	46.7	47.3	26.8	36.1	24.3	47.4	22.1	53.2	33.9	35.2	39.8	25.1	39.6	44.0	32.2
1947	47.2	47.7	29.1	37.2	26.6	45.6	24.7	54.0	35.0	42.2	46.5	26.2	45.5	48.6	34.6
1946	50.9	51.5	31.4	43.4	28.6	49.8	27.6	56.4	36.1	39.7	44.5	30.9	52.7	55.4	36.3
1945	48.5	49.0	35.0	40.1	29.7	46.3	32.0	54.6	39.3	39.5	44.0	35.2	52.0	54.4	39.8
1944	48.4	48.9	36.1	38.1	31.7	44.2	33.5	56.4	39.0	41.6	46.1	36.6	54.3	56.7	41.6
1943	51.4	51.9	31.9	41.0	29.6	49.1	28.9	56.4	34.3	46.2	50.4	27.8	58.6	60.9	39.3
1942	50.5	51.0	29.4	39.5	32.4	49.0	25.7	56.2	31.2	43.3	48.1	30.8	53.1	56.0	37.5
1941	44.7	45.8	30.2	34.9	31.9	42.6	27.1	51.9	32.2	38.8	45.0	28.7	45.4	49.2	37.9
1940	35.8	36.7	30.8	28.7	28.6	31.1	27.5	47.1	33.7	27.2	35.5	29.6	32.2	37.7	39.6
1939	36.3	37.2	32.4	29.9	30.7	32.0	28.4	47.3	35.5	24.8	34.0	31.2	29.1	35.2	43.0
1938	35.2	36.2	33.7	30.6	31.2	30.0	30.0	46.2	36.3	22.8	33.0	34.3	30.8	37.7	44.3
1937	43.5	44.5	30.8	34.6	28.3	42.5	25.2	54.0	35.2	17.9	29.1	35.0	32.9	39.5	43.1
1936	35.6	37.0	31.3	31.9	26.8	26.7	28.5	48.9	34.1	27.8	38.5	30.3	36.4	42.8	36.5
1935	42.1	43.4	28.1	34.6	27.3	41.8	22.9	51.0	33.3	25.6	37.5	29.6	33.0	40.3	36.8
1934	23.9	25.4	33.5	24.5	29.7	4.7	31.8	44.7	35.1	−0.2	17.4	36.0	29.5	38.1	36.5
1933	18.5	20.4	36.1	24.6	30.4	3.0	33.0	37.9	41.1	−9.7	10.4	35.6	16.3	27.7	38.5
1932	2.3	5.0	42.7	16.0	37.9	−6.9	38.1	18.2	49.3	−32.7	−5.9	42.0	−10.4	6.7	48.9
1931	13.9	16.4	43.1	25.4	38.5	6.7	37.1	29.5	51.4	−34.0	−6.0	45.4	0.7	16.8	48.2
1930	20.0	22.2	43.5	29.7	36.3	15.5	37.2	32.3	52.6	−14.6	8.1	45.9	4.4	19.3	52.5
1929	32.6	34.4	38.7	31.7	36.0	27.9	33.5	47.2	45.5	6.7	24.6	37.5	17.5	30.0	43.6
1928	31.5	33.4	39.0	28.9	37.3	27.2	33.9	44.8	46.8	15.8	32.5	34.5	16.9	29.7	42.6
1927	30.7	32.5	39.9	31.0	39.1	24.7	35.0	44.6	47.4	20.2	36.8	33.1	14.0	27.8	44.1
1926	30.8	31.9	41.0	35.5	37.6	22.6	34.1	46.7	50.7	12.1	31.7	36.9	11.9	26.5	45.4
1925	34.2	36.1	37.8	35.3	37.6	26.6	32.3	50.7	45.2	14.0	33.8	34.3	17.5	31.7	40.2

* Estimates A and B are calculated by the two alternative residual methods. Estimate C is calculated by the hired-wage-rate method. Boldface numbers indicate years when the two estimates diverge by no more than 4.0 percentage points.

however, that these assumptions have been met even approximately during only a few years since the mid-1920's. It seems likely that use of the residual approach will result in underestimates of labor returns during years when farm prices are declining and in overestimates during years when farm prices are rising. Estimate A is the residual estimate of labor's share when the estimated value of land not in farms in the western states is included. Estimate B is the residual estimate of labor's share when the estimated value of land not in farms in the western states is omitted.

The *second* approach (Estimate C in Table 2) used in estimating labor income was to multiply the average hourly earnings of hired workers in each region times the number of hours worked by all farm workers in each region.[16] This approach assumes that all family workers, including the operator, received the same return on their labor as hired farm workers. Because of lag in the response of wage rates to changes in marginal productivity, it seems likely that this approach will tend to overestimate the return to labor during periods when farm prices are declining and underestimate the return to labor during periods when farm prices are rising. During periods of relative stability, we should expect to find that the two series yield approximately identical results. The data in Table 2 bear out this expectation.[17]

It should be noted that estimation of labor's share directly from wage rate data (Estimate C) results in a more stable estimate of both the labor

[16] The "index of composite farm labor wage rates," by regions, as reported in *Farm Labor*, Dec. 11, 1950, and Jan. 10, 1958, was used to compute the "average annual hourly composite wage rate" for years prior to 1947. For the years 1948-1957, the "average annual hourly composite wage rate" was reported in *Farm Labor*, Jan. 10, 1958. The wage rate, by regions, was then multiplied by "man-hours of labor for farm work," provided by R. W. Hecht, Prod. Econ. Res. Branch, Agr. Res. Serv. An index series for "man-hours of labor used in farm work" for the U. S. and major agricultural regions is published in *Changes in Farm Production and Efficiency, Summary Report and Supplement II*, U. S. Dept. Agr. Stat. Bull. 233, Aug. 1958. Alternative measures of labor input are available: (a) Use of the number of farm workers reported in the U. S. Bur. Census, *Annual Report on the Labor Force*, would have resulted in somewhat lower estimates of labor inputs. Unfortunately, the *Annual Report on the Labor Force* does not present regional estimates of farm employment. (b) The USDA farm employment series also shows a somewhat different pattern of change than the USDA man-hour series. The USDA employment series is available on both a regional and a national basis.

[17] This pattern of variability should be of particular interest to those engaged in estimating the feasibility of long-term resource investment programs or projects. The "aggregate budgeting" techniques used to determine the feasibility of such investments typically employ the value of some residual, such as the residual return to labor, management, or capital, after certain itemized expenditure or cost items are deducted, to estimate feasibility or repayment ability. The fluctuations observed in the return to labor when estimated on a residual basis emphasize both (a) the extreme variability of any such residual and (b) the possibility of substantial secular trends in the individual factor shares. One can barely escape risking the judgment that the financial difficulties which have faced many irrigation and drainage enterprises during the last three decades are related, in part at least, to the relative decline in the share of total agricultural income attributable to land.

TABLE 3A. FACTOR SHARE ESTIMATES BY REGIONS FOR SELECTED YEARS, GROSS INCOME BASIS

Region	Gross output	Current operating expenses	Net output	Capital						Labor		
				Buildings	Non-real estate	Land		Total		Residual		Computed
						A	B	A	B	A	B	C
	Per cent											
United States												
1925–1928	100	31.1	68.9	8.6	9.8	18.6	17.0	37.0	35.4	31.8	33.5	39.4
1938–1940	100	34.9	65.1	7.4	10.7	11.2	10.2	29.3	28.3	35.8	36.7	32.3
1954–1957	100	41.6	60.1	6.6	14.6	11.5	10.7	32.7	31.9	25.7	26.6	25.7
Northeast												
1925–1928	100	37.5	62.5	13.1	9.6	—	7.1	—	29.8	—	32.7	37.9
1938–1940	100	44.2	56.8	11.1	9.9	—	5.2	—	26.2	—	29.7	30.5
1954–1957	100	49.0	52.9	9.3	14.3	—	4.3	—	27.9	—	23.1	25.2
North Central												
1925–1928	100	32.7	67.3	10.3	11.7	—	20.0	—	42.0	—	25.3	33.8
1938–1940	100	36.4	63.6	8.6	13.1	—	10.9	—	32.6	—	31.0	28.6
1954–1957	100	43.0	58.7	6.9	17.2	—	9.9	—	34.0	—	23.0	24.2
South												
1925–1928	100	25.2	74.8	6.3	7.8	—	14.5	—	28.4	—	46.8	47.5
1938–1940	100	28.4	71.6	5.8	8.8	—	10.2	—	24.8	—	46.9	35.2
1954–1957	100	38.4	63.4	6.4	13.0	—	11.5	—	30.9	—	31.0	28.1
Mountain												
1925–1928	100	33.1	66.9	4.6	12.2	34.4	16.4	51.2	33.2	15.7	33.7	34.7
1935–1936	100	34.0	66.0	5.2	10.8	23.4	12.3	39.4	28.3	26.7	37.8	30.0
1938–1940	100	38.7	61.3	4.3	11.9	20.1	10.8	36.3	27.0	24.9	34.2	31.8
1954–1957	100	42.7	59.3	4.6	16.2	20.7	14.6	41.4	35.4	15.8	22.0	23.2
Pacific												
1925–1928	100	35.5	64.5	5.8	6.7	37.0	23.1	50.4	35.5	15.1	29.0	43.0
1935–1936	100	33.1	66.9	5.8	5.7	20.8	13.9	32.3	25.4	34.7	41.6	36.6
1938–1940	100	37.5	62.5	5.3	6.9	19.6	13.4	31.8	25.6	30.7	37.0	42.6
1954–1957	100	38.3	62.8	4.6	8.3	17.4	13.9	30.3	26.8	31.3	34.9	26.1

and nonlabor (all capital) shares than when the nonlabor (all capital) shares are estimated directly from interest rate and depreciation data and labor is treated as a residual (Estimates A and B). For years between the "stability" or "equilibrium" periods identified in Table 2, Estimate C is, therefore, probably to be preferred to Estimates A or B.

Regional Differences

Years in which factor shares estimated by the residual method yield approximately the same results as factor share estimates based on market rates provide the soundest basis for comparison, both among regions and over time. Close correspondence or a highly stable differential between the results obtained from the two methods of estimation provides at least indirect evidence that factor price ratios are roughly equivalent to factor share ratios.

It appears, from the data presented in Table 2, that the years 1925-28, 1938-40, and 1954-57 meet this criterion more closely than any other years covered in this study. In the two western regions, 1935 and 1936 appear to be superior to 1938-40. Johnson[18] and Scofield[19] have also noted that,

[18] Johnson, "Allocation of Agricultural Income," *op. cit.*, pp. 732-33, 738.

[19] Scofield, W. H., and R. D. Davidson, *The Farm Real Estate Situation 1947-48 and 1948-49*, U. S. Dept. Agr. Circ. No. 823, 1949, pp. 31-38.

TABLE 3B. FACTOR SHARE ESTIMATES BY REGIONS FOR SELECTED YEARS, NET INCOME BASIS

Region	Net output	Capital						Labor		
		Buildings	Non-real estate	Land		Total		Residual		Computed
				A	B	A	B	A	B	C
	Percent									
United States										
1925–1928	100	12.5	14.3	27.0	24.6	53.8	51.3	46.2	48.6	57.2
1938–1940	100	11.3	16.5	17.2	15.7	45.0	43.5	55.0	56.5	49.8
1954–1957	100	11.2	25.0	19.8	18.3	56.0	54.5	44.0	45.5	43.9
Northeast										
1925–1928	100	21.0	15.3	—	11.4	—	47.7	—	52.2	60.6
1938–1940	100	19.8	17.7	—	9.3	—	46.8	—	53.2	53.7
1954–1957	100	18.2	28.1	—	8.4	—	54.7	—	45.3	49.3
North Central										
1925–1928	100	15.3	17.4	—	29.7	—	63.5	—	37.6	50.0
1938–1940	100	13.5	20.7	—	17.1	—	51.2	—	48.8	54.2
1954–1957	100	12.1	30.1	—	17.4	—	59.6	—	40.4	42.6
South										
1925–1928	100	8.4	10.5	—	19.4	—	38.3	—	62.6	63.5
1938–1940	100	8.1	12.2	—	14.2	—	34.5	—	65.5	49.7
1954–1957	100	10.4	21.2	—	18.8	—	50.4	—	49.7	45.7
Mountain										
1925–1928	100	6.9	18.2	51.5	24.5	76.6	49.6	23.5	50.4	51.8
1935–1936	100	7.8	16.3	35.4	18.6	59.0	42.6	41.0	57.5	45.6
1938–1940	100	7.1	19.5	32.8	17.7	59.3	44.2	40.7	55.9	51.8
1954–1957	100	8.0	28.2	36.2	25.5	72.4	61.6	27.6	38.4	40.6
Pacific										
1925–1928	100	9.0	10.4	57.3	35.8	76.7	55.2	23.4	44.9	66.7
1935–1936	100	8.7	8.5	31.0	20.8	48.2	37.9	51.8	62.1	54.7
1938–1940	100	8.4	11.1	31.3	21.4	50.8	40.8	49.2	59.3	68.2
1954–1957	100	7.4	13.5	28.2	22.5	49.1	43.4	28.2	56.6	42.3

at the national level, the criterion was approximately satisfied in the earlier two of the three periods listed. On the basis of our test, the period 1954-57 appears to provide a better basis for comparison than any of the earlier periods.

The estimated percentage distribution of gross and net agricultural income in the United States and in five major agricultural regions is presented for the periods 1925-28, 1938-40, and 1954-57 in Tables 3A and 3B. In addition, the percentage distribution is presented for the Mountain and Pacific regions for 1935-36. This procedure is adopted to permit easier comparison of the data between the several "stability" or "equilibrium" periods. A disadvantage of presenting the data in this manner is that it fails to reveal the full range of variation in factor shares that has occurred between 1925 and 1955. (For those who are interested in exploring the data in greater detail, the factor share allocations for all factors for each year since 1925 are available from the authors on request.)

Labor Inputs

When estimated on the basis of wage rates paid to hired labor and total hours worked (Estimate C), the share of both gross and net income allocated to labor has tended to decline rather sharply, both at the national

level and in each of the five major regions, over the period studied. On the other hand, the residual methods (Estimates A and B) indicate a modest decline in the share of gross income and little change in the share of net income allocated to labor for the nation as a whole. There is, however, considerable divergence among the several regional estimates. In spite of the trend differences among the several estimates, there appears to be a tendency for the estimates to converge over time at approximately 25 per cent of gross farm income and 45 per cent of net farm income.

The 1954-57 years were the first in the 31-year period under study in which labor returns calculated both on a residual basis and on the basis of wage rates paid to hired labor were in what might be called an "equilibrium" relationship to each other in more than three regions at the same time. In 1954-57, the two methods diverged by more than four percentage points only in the Pacific region, and even in the Pacific region the relationship between the several labor share estimates remained quite stable for the five year period 1954-57.

Johnson, in his study, commented on the tendency for the labor share to be greater when computed on the basis of hired farm worker wage rates than when computed by the residual method.[20] While this relationship held at the national level in earlier years covered in this study, it generally has not held since the late 1930's. The general pattern is for factor shares computed on the basis of wage rates to exceed factor shares computed as residuals during periods of deflation and to fall below factor shares computed as residuals during periods of inflation. Both the South and the Pacific regions departed from this general pattern. In the South, the residual method resulted in a higher estimate of labor's share than did the hired-wage-rate method during the 23-year period 1934-56. And during the period 1925-33, the results obtained by the two methods were in closer agreement in the South than in the other regions. Apparently the large supply of underemployed farm workers and the low level of industrial employment relative to agricultural employment in the South[21] tended to isolate the farm labor market there from other social and economic forces operating during the period. This isolation of the farm labor market resulted in farm wage rates that were sufficiently low to permit relatively close correspondence between the two estimates of the share of income allocated to labor.

The Pacific region followed the general pattern until the latest equilib-

[20] Johnson, "Allocation of Agricultural Income," *op. cit.*, p. 739.

[21] It was not until after World War II that employment in manufacturing in the Southeast exceeded employment in agriculture. See Robock, Stefan H., "Industrialization and Economic Progress in the Southeast," *Southern Econ. Jour.*, 20:307-27 (April, 1954).

rium period, 1954-57. During this period the residual method continued to show a higher share allocated to labor than the hired wage rate method rather than convergence of the two estimates. In spite of the failure of the series to converge in 1954-57, it is too early to conclude that the large-scale organization of agriculture, particularly in California, is capable of holding the returns to operator and family labor permanently above the hired farm worker wage rate level.

Capital (buildings, land, and non-real-estate capital)

1. The share of income allocated to all capital items, including buildings, land, and non-real-estate capital, ranged from 28 to 42 per cent of gross agricultural income and from 38 to 77 per cent of net agriculture income in 1925-28. Since 1925-28, the range has narrowed considerably –tending to converge toward approximately 30-35 per cent of gross agricultural income and 55 per cent of net agricultural income. This convergence is generally being achieved by a substantial decline in the share of income allocated to land, a slight decline in the share allocated to buildings, and rapid substitution of non-real-estate capital for land. The decline in the share allocated to land occurred in the early part of the period studied. In recent years there has been some tendency for the share allocated to land to rise.

The share of both net and gross income allocated to the three capital items is higher in the North Central region than in other regions during each period. No single region consistently occupies the lowest position with respect to total capital inputs. During the first two periods the share of both gross and net income allocated to capital is lowest in the South. The share of gross income is also low in the Northeast reflecting the substitution of current operating expenses for locally-owned capital inputs—mainly land and non-real-estate capital. By the 1954-57 period the share of both gross and net income allocated to capital was lower in the Pacific region than in either the Northeast or the South. In the Mountain region the share of income allocated to the three capital items when Estimate A is employed is considerably larger than in other regions. Use of Estimate B brings the share allocated to capital in the two western regions more closely in line with the share allocated to capital in the other regions.

2. Differences in the composition of capital inputs (land, buildings, and non-real-estate capital) among the several regions can apparently be traced primarily to differences in resource endowments and market possibilities.

(a) The relatively low share of income allocated to land and the relatively high share allocated to buildings in the Northeast reflects the relatively poor land resource endowments of the region; the major emphasis

on fluid milk production in the region made possible by location near the nation's major population centers; and the possibility (or necessity) of importing feed grains from the North Central region.

(b) The relatively high share of income allocated to non-real-estate capital in the North Central region reflects the availability of land resources of a type that permits an extensive mechanized agriculture directed to the production of food and feed grains and a livestock economy based on the feed grains produced by this extensive agriculture.

(c) The rapid increase in the share of income allocated to non-real-estate capital in the South reflects the substitution of capital for labor that has occurred in the South during the last decade and a half. The share allocated to buildings has been traditionally low. Its stability over the period studied reflects a shift toward commercial livestock and poultry production in an area which has previously relied mainly on cash crops.

(d) The situation in the Mountain and Pacific regions is not entirely clear. If estimate A is employed as the share of income allocated to land, then land inputs clearly represent a much larger share of total inputs in the two western regions than in the three eastern regions. If Estimate B is employed, the share allocated to land in the two western regions tends to be only slightly higher than in the three eastern regions. It seems reasonable, both because of the very extensive type of agriculture which prevails in much of the West and the very high investment associated with irrigation agriculture in the West, to expect that land would account for a higher share of total inputs than in the eastern regions. When the factor share estimates for land are considered in relation to the residual factor share estimates for labor (A and B), it seems unlikely that the factor share allocated to land should be as high as indicated by Estimate A. On the other hand, use of Estimate B appears to result in a rather high residual factor share estimate for labor in the Pacific region. Our conclusion is that Estimate B results in some underestimation of the factor share which should be allocated to land but that it is better than Estimate A.

Current operating expenses and taxes

Current operating expenses and taxes have risen from approximately 25 per cent of total United States gross farm income in 1910-14 to 31 per cent in 1925-28 and 42 per cent in 1954-57. In both 1925-28 and 1954-57 the share of gross income allocated to current operating expenses was highest in the Northeast. The share allocated to current operating expenses in 1925-28 was lowest in the South. By 1954-57 this position was occupied jointly by the South and Pacific regions. The Northeast and the South experienced larger increases in the percentage share of income allocated to current operating expenses than the other regions. Indeed, the develop-

ment in southern agriculture during the last 15 to 20 years seems to be creating an agriculture that is structurally similar in many respects to the northeastern situation of 30 years ago. Compare, for example, the share of gross farm income accounted for by the three major factors in the two regions (see Table 4).

TABLE 4. COMPARISON OF FACTOR SHARE ESTIMATES, NORTHEAST (1925–28) AND SOUTH (1954–57)

Region	Gross output	Current operating expenses	All capital	Labor
		per cent		
Northeast (1925–1928)	100	37.5	29.8	32.7
South (1954–1957)	100	38.4	30.9	31.0

One should not draw the implication that history is repeating itself in any great detail. The agreement is not nearly as close with respect to individual capital components. One is struck, however, by the fact that parts of the South, particularly the South Atlantic and East South Central regions, are adopting an agriculture that is similar to that of the Northeast in at least two major respects: (a) growth of animal agriculture which relies on outside sources for a substantial part of its feed concentrate requirements, and (b) the shifting of a substantial acreage of land from crop production to the production of hay, pasture, or forest products.

One is also struck by the very limited increase in the share of income accounted for by current operating expenses in the Pacific region. While a rather substantial shift was apparently taking place between the factor shares allocated to capital and labor, current operating expenses experienced only a slight change relative to gross agricultural income. This apparently reflects the relatively high level of commercial agriculture that existed in the Pacific region even by the mid-1920's when agriculture in other regions, including the Midwest, was only beginning to shift from a family to a large-scale, commercially oriented activity.

A question for the future

Is there any long-run economic significance to the apparent tendency for the share of income allocated to the long-term capital inputs (land, buildings, and non-real-estate capital) in the several regions to converge toward a common level somewhere in the neighborhood of 30-35 per cent of gross agricultural income and 55 per cent of net agricultural income? Two factors seem to have been of importance in forcing this convergence over the last 30 years.

One of these factors has been the increase in the magnitude of current operating expenses relative to other factors. By substituting current operating expense items (that is, operating capital) for land, buildings, and non-real-estate capital, the absolute share going to the longer term capital inputs, particularly land, has been reduced. Substitution of fertilizer for land, for example, has apparently been particularly effective in reducing the importance of the original differences in land resource endowments among regions.

The *second,* and probably more important factor, has been the closer relationship that has developed between the farm and the nonfarm labor markets over the last few decades, particularly in the South. This adjustment, which has taken place mainly through adjustments in labor utilization rather than changes in the structure of wage rates in agriculture,[22] has resulted in more uniform capital-labor ratios in the several regions.[23]

It seems likely that shifts in the utilization of farm labor will continue to respond to differentials in labor productivity and wages between the agricultural and non-agricultural sectors of the economy in a manner that will contribute to even greater uniformity in capital-labor ratios among regions. There would seem to be little basis, however, for hypothesizing whether the pattern of technological change that will emerge in the future will contribute to greater or less uniformity among regions in the ratio of current operating expense (that is, operating capital) to long-term capital investment. To the extent that the experience of the Pacific region can be taken as a guide to the movement of the current operating expense ratio under a highly commercial agriculture, it seems unlikely that the current operating expense ratio will continue to rise as rapidly during the next several decades as it has in the past two and a half decades.

[22] See Wolfson, Robert J., "An Econometric Investigation of Regional Differentials in American Agricultural Wages," *Econometrica,* 26:225-57, 1958. According to Wolfson, "There is a stable and persistent pattern of significantly large differentials in money wages paid to hired agricultural labor in the United States." (*ibid.,* p. 228).

[23] For example, the capital-labor ratios estimated from the B capital estimates and the C labor estimates from Table 3 in 1925-1928 and 1954-57 in the several regions were:

Years	United States	North-east	North Central	South	Moun-tain	Pacific	s^2	s
1925–28	100	92	146	70	113	97	797.8	28.2
1954–57	100	86	113	90	123	80	336.0	18.3

Calculations based on alternative labor and capital estimates also indicated a reduction in the variation among regions between 1925-1928 and 1954-1957.

ANIMAL PRODUCTION FUNCTIONS AND OPTIMUM RATION SPECIFICATIONS*

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MUCH well-deserved interest in the use of linear programming to minimize the cost of rations meeting certain specifications has resulted from previous research by agricultural economists and others.[1] These interesting methods have proven useful, allowing a large number of specifications to be met by the cheapest possible combination of feed ingredients. However useful though these methods have been in minimizing feed cost, cost is only part of the total problem. Returns must also be considered to find the most profitable combination of feed ingredients for the ration.

No consideration of returns is given by the usual linear programming formulation of the least-cost problem. Thus far, agricultural economists have assumed that "recommended" levels of protein, energy, minerals, etc. are economically optimum for linear programming. While the economist cannot be expected to know *a priori* what the optimum levels are, he should recognize that determining the optimum levels of these specifications is an economic problem—and an economic problem that may not yet have been solved by the biological scientist. That is, economists should realize that setting the levels of the specifications is also part of the problem.

At first thought, marginal analysis of production economic theory would seem to afford a better approach than the linear programming least-cost model. Marginal revenue could then be balanced against marginal cost and profits could be maximized with a specified set of ingredients. Production surfaces have been estimated and marginal analysis actually

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[1] Some applications of least-cost linear programming were made by the following: F. V. Waugh, "The Minimum-Cost Dairy Feed," *J. Farm Econ.*, 33:299-310, Aug. 1951; W. D. Fisher and L. W. Schruben, "Linear Programming Applied to Feed Mixing Under Different Price Conditions," *J. Farm Econ.*, 35:471-83, Nov. 1953; R. F. Hutton and J. R. Allison, "A Linear Programming Model for Development of Feed Formulas Under Mill-Operating Conditions," *J. Farm Econ.*, 39:94-111, Feb. 1957; R. F. Hutton and R. H. McAlexander, "A Simplified Feed-Mix Model," *J. Farm Econ.*, 39:714-30, Aug. 1957; R. F. Hutton, G. A. King, and R. V. Boucher, "A Least-Cost Broiler Feed Formula Method of Derivation," Prod. Res. Rept. No. 20, A.R.S., A.M.S., U.S.D.A. in Cooperation with Pa. Agr. Expt. Sta., Washington, D. C., May 1958, 39 pp.

used to specify the optimum combinations of certain feeds such as corn, barley, or soybean meal.[2]

Other feeds or ingredients of equal feeding value could be substituted for the specific feeds considered in the marginal analysis studies. However, the extent of coverage of certain fundamental nutritional variables, such as energy, has not been adequate for these feeding experiments set up in terms of specific feeds.

It was the intent of this study to use an approach general enough to conveniently consider many feed ingredients, as in linear programming, but which would allow comparison of profits for different levels of the more economically important nutritional variables. Existing experimental data appeared inadequate to achieve this objective. Consequently, a specially designed experiment was conducted.

Experimental Design as Related to Basic Hypothesis

Since the aim was to predict broiler weight for a range of ration specifications, the first problem was to decide which nutritional specifications to vary in the experiment. For poultry feeds, changes in protein and energy levels generally have by far the greatest impact on ration cost per ton. Small shifts in the vitamin or mineral specifications do not usually cause nearly as much change in ration cost. For example, $3 or $4 would cover the cost of vitamins per ton of broiler mash. For this reason, levels of energy and protein were varied while mineral and vitamin specifications were held constant. Amino acid levels approximately equalled or exceeded required levels within the protein levels calculated on a proportional basis, using National Research Council requirements for amino acids at the 20 percent protein level. Protein quality was thereby maintained constant within protein levels.

Because interaction between protein and energy is believed by nutritionists to be quite important (as indicated by emphasis on properly "balanced" rations and Calorie-protein ratios) a factorial experimental design was used. Four levels of protein (16%, 21%, 26%, and 32%) were combined with three energy levels (1200, 1400, and 1600 Calories of metabolizable energy per pound) to give 12 different protein-energy combinations. Each of the 12 treatments was replicated, giving a total of 24 pens.

Animal fat, a crude fiber source, soybean meal, and corn served as variables for arriving at the desired protein and energy levels as shown in Table 1. Added choline and methionine were used where needed. It

[2] For one of the early uses of this method cf. E. O. Heady, R. C. Woodworth, D. N. Catron, and G. C. Ashton, *New Procedures in Estimating Feed Substitution Rates and in Determining Economic Efficiency in Pork Production*, Iowa Agr. Expt. Sta. Res. Bull. 409, Ames, Iowa, May 1954.

TABLE 1. COMPOSITION OF EXPERIMENTAL RATIONS

Protein, percent	16			21			26			32		
Metabolizable Energy, Cal./lb.	1200	1400	1600	1200	1400	1600	1200	1400	1600	1200	1400	1600
	Pounds			*Pounds*			*Pounds*			*Pounds*		
Corn, yellow, grd.	1173	1173	1173	907	907	907	642	642	642	323	323	323
Animal fat[1]	20	120	220	51	151	251	82	182	282	120	220	320
Fiber[2]	270	170	70	254	154	54	239	139	39	220	120	20
Soybean meal, sol. dehulled (50% Prot.)	200	200	200	450	450	450	700	700	700	1000	1000	1000
Methionine (98%)	0.5	0.5	0.5	1	1	1	2	2	2	3	3	3
Choline Cl. (25%)	3	3	3	—	—	—	—	—	—	—	—	—
Constant ingredients[3]	336	336	336	336	336	336	336	336	336	336	336	336

[1] Stabilized prime tallow.
[2] Solka-Floc B.W.-100.
[3] Constant ingredients (lbs.): fish meal, herring (70% Prot.), 100; corn gluten meal, 60; whey, dried, 50; alfalfa meal, dehy. (20% Prot.), 40; bone meal, sp. st., 45; limestone flour, 25; vitamin and mineral premix (Nopcosol-M-5), 10; salt, iodized, 6.

should be noted that animal fat was given a metabolizable energy value of 3960 Calories per pound in arriving at these energy levels.[3] Thus, spacings of energy and protein levels were designed to give an adequate coverage of the protein-energy surface.

Twelve Delaware X New Hampshire autosexed chicks containing an equal number of males and females were included in each group. The chicks were raised in electrically heated batteries to four weeks of age and then transferred to finishing batteries for the duration of the experiment. Feed and water were supplied *ad libitum*.

Data on growth and feed consumption were obtained at 4, 8 and 9 weeks of age. Daily mortality records were kept with feed conversion values adjusted for mortality.

TABLE 2. BROILER WEIGHTS IN POUNDS AND FEED CONVERSION RATES AT 9 WEEKS FOR VARIOUS PROTEIN AND ENERGY LEVELS[a]

Protein Level		Metabolizable Energy Level[b]		
		1200 Cal./lb.	1400 Cal./lb.	1600 Cal./lb.
16%	Broiler wt.	2.42	2.71	2.67
	Feed conv.[b]	(3.09)	(2.72)	(2.53)
21%	Broiler wt.	2.66	3.04	3.22
	Feed conv.	(2.95)	(2.57)	(2.27)
26%	Broiler wt.	2.79	3.14	3.28
	Feed conv.	(2.94)	(2.52)	(2.34)
32%	Broiler wt.	2.72	3.02	3.02
	Feed conv.	(3.08)	(2.57)	(2.22)

[a] Each entry is the average of 2 pens.
[b] Feed conversion rates were computed by dividing pounds of feed fed by bird weight.

[3] H. W. Titus, *The Scientific Feeding of Chickens*, 2nd ed. with addendum, 1955, The Interstate, Danville, Ill., p. 250.

Experimental Results and Analysis

Experimental results from 12 protein-energy combinations are shown in Table 2. Although final broiler weights were lower and feed conversion rates relatively higher for either low protein or low energy rations, any of the medium or high protein and energy rations gave efficient feed conversion. Benefit from protein beyond 21 percent appeared to diminish rapidly. On the other hand, the highest metabolizable energy (M.E.) level of 1600 Calories per pound continued to give a better (lower) feed conversion rate than the medium energy level of 1400, although at a diminishing rate of improvement.

Of various algebraic functions fitted, the following regression equation best characterized the growth relationships of the experimental findings:

$$(1) \qquad Y = 0.097 + 0.2371C + 0.5217P - 0.009829C^2 - 0.3701P^2 + 0.09106CP$$

In the above equation, Y refers to predicted broiler weight in pounds; C, kilo-Calories of metabolizable energy consumed; and P, pounds of protein consumed. All five regression coefficients were very highly significant according to t-test. Approximately 99.75 percent of the total variation was accounted for by Equation (1). It should be noted that Equation (1) was fitted to the 24 pen means at 0, 4, 8, and 9 weeks of age. Therefore, the coefficient of determination, R^2, of 0.9975 is somewhat higher than if calculated from individual bird weights within the pens. However, the variation between pen means is the appropriate measure in this case since we had no record of the feed consumed by individual birds within the pens.

It was shown in a previous paper that for production situations, where time is required for additional inputs of factors, time should be integrated into the analysis.[4] Consequently, the rate of factor input or intake —in this case, the rate of feed consumption per bird—was also estimated from the basic experimental results. Examination of the experimental data showed that total pounds of feed consumed per bird (averaged across all energy levels) increased with increased protein up to 26 percent, then diminished. Total pounds of feed consumption declined as the caloric content of the feed was increased. The following regression equation summarizes these relationships:

$$(2) \qquad F = 0.09146C'T + 0.4880P'T - 0.02980(C')^2T - 0.6398(P')^2T - 0.1091C'P'T - 0.1094T + 0.001923T^2$$

In Equation (2), F refers to predicted pounds of feed consumed per

[4] W. G. Brown and G. H. Arscott, "A Method for Dealing with Time in Determining Optimum Factor Inputs," *J. Farm Econ.*, 40:666-673, Aug. 1958.

bird; C', kilo-Calories of metabolizable energy per pound of feed; P', the proportion of protein per pound of feed; and T refers to time, i.e., the length of feeding period in days. Equation (2) was fitted to the 24 pen means at the 0, 4, 8, and 9 week periods, as was the production function, Equation (1). Logically, the interaction of the time variable with the feed composition terms is well chosen since time is required for feed consumption, regardless of feed composition. Over 99.5 percent of the total variation in feed consumption was accounted for by Equation (2). Again, there would likely be a greater unexplained variation of individual bird feed consumptions than indicated. However, these individual bird feed records are not available in this type of experiment.

Marginal Analysis and the Energy-Protein Model

Traditionally, production surfaces have been employed in dealing with problems of optimum factor inputs. Energy-protein relationships can also be illustrated in this manner as in Figure 1. Isoquants are computed and plotted in the usual manner. However, a complication develops in the calculation of isoclines and optimum inputs. What figures should be used to represent the marginal cost of protein and energy?

The answer to this question can be worked easily for the simplest situation with only two ingredients. For example, if dehulled soybean meal (S) contains 50 percent protein, has an energy value of 1.14 kilo-Calories of M.E. per pound and costs \$0.04 per pound as compared to corn (C) with 8 percent protein, an energy value of 1.5 kilo-Calories and a cost of \$0.02 per pound, then the cost of an additional pound of protein can be calculated from the simultaneous solution of the following equations:

(3) Protein equation: $1 = 0.5S + 0.08C$

(4) Energy equation: $0 = 1.14S + 1.5C$

Solving (3) and (4) results in a value of 2.2769 for S and -1.7304 for C. Thus, the addition of 2.2769 pounds of soybean meal and the deletion of 1.7304 pounds of corn would mean an additional pound of protein while maintaining the same energy level. The cost would be \$0.04 (2.2769) + \$0.02 (-1.7304) = \$0.0565 for the additional pound of protein.

In the same way, if the constant term in (3) is set equal to zero and in (4) is equal to one, S is equal to -0.1214 and C is 0.7590. Thus, the cost of an additional kilo-Calorie of M.E. would be \$0.04 (-0.1214) + \$0.02 (0.7590) = \$0.0103.

If marginal analysis were to be employed, some series of calculations as the preceding method could be used to yield correct figures for the marginal costs associated with various specifications. Another method which also could be used would be to rewrite Equation (1) in terms of

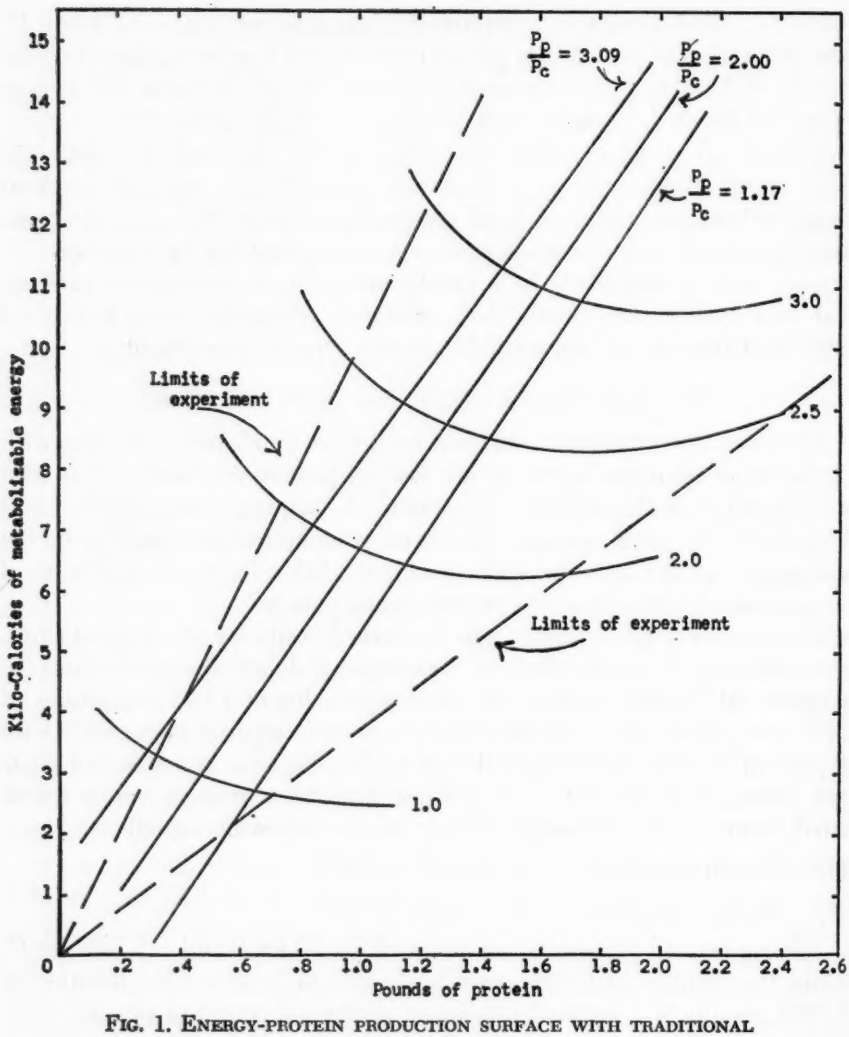

FIG. 1. ENERGY-PROTEIN PRODUCTION SURFACE WITH TRADITIONAL ISOQUANTS AND ISOCLINES

soybean meal and corn. Marginal costs associated with given specifications can also be determined by linear programming. However, with many feed ingredients and other feed restrictions and specifications (as for poultry feeds) the direct use of marginal analysis does not appear to be convenient.

Use of Linear Programming in Conjunction with the Energy-Protein Model

Linear programming was used most satisfactorily to find least-cost feed mixtures for various protein and energy specifications. This procedure

has the advantage of keeping other specifications at their proper level. For example, certain essential amino acids equalled or exceeded recommended levels in proportion to the total protein per ton. Various protein and energy specifications then properly corresponded to scale lines for the calorie-protein production surface of Figure 1. Linear programming was used to determine the cheapest combination of feed ingredients which would meet the requirements of various scale lines over the production surface in Figure 1.

The linear programming model employed was similar to a model recommended for the feed industry.[5] Separate solutions were obtained for several energy levels within a number of protein levels.[6] The programming model included equations for weight, calcium, phosphorus, arginine, lysine, methionine, methionine plus cystine, tryptophan, as well as two additional equations which limited the quantity of mill run and middlings which could enter the solution.

Equation (2) was used to predict the pounds of feed with given protein and energy which could be consumed per bird for various feeding periods. That is, Equation (2) gave estimates of how far out on the scale lines it would be possible to go within certain time periods on the production surface in Figure 1. The margins over feed cost for these various points on the production surface were calculated and the ration specification corresponding to the highest profit position was selected.

Under the feed costs and depressed broiler prices prevailing in the Pacific Northwest during the three months of January, February, and March, 1959, the most profitable ration specification was 20 percent protein and 1450 Calories of M.E. per pound. The variable portion of this ration was composed of about 53 percent corn, 16 percent milo, 2 percent animal fat, 14 percent cottonseed meal, 4 percent fish meal, 5 per cent meat and bone scrap, 0.1 percent synthetic methionine, and 1 percent limestone. The premix contained 3 percent fish meal, 2 percent alfalfa meal, and less than 1 percent of a vitamin-mineral mixture.

According to the analysis based on Equations (1) and (2), it would have paid best to feed the broilers 10 weeks to about 3.5 pounds per bird. This

[5] Cf. R. F. Hutton, G. A. King, and R. V. Boucher, *op. cit.*

[6] Reviewers have suggested that an alternative approach would be to use treatment results reported in Table 2, plus the data from other weighing periods, as specifications for the activities. The various activities could then be incorporated into the feed mix model to give the simultaneous selection of length of production period, caloric content of feed, protein content of feed, and the mix of ingredients.

This suggestion to simultaneously solve these various aspects of the problem in one programming model has considerable appeal. However, the authors think that there would be an appreciable loss of information in foregoing the use of Equations (1) and (2). It should be possible to set up the single model and still utilize Equations (1) and (2) to provide point estimates of feed consumption and broiler weights for assumed lengths of feeding periods and ration specifications.

predicted feeding period of 10 weeks is an extrapolation of one week beyond the nine weeks of the experiment; hence, it is accepted with some reservations.

As might be expected, rations with nutrient composition fairly close to the optimum (20 percent protein, 1450 Calories of M.E. per pound) were only slightly less profitable. Next highest in order of profitability for the 10-week feeding period were the rations with the following specifications:

21% Protein	1500 Cal. of M.E. per lb.
21% Protein	1450 Cal. of M.E. per lb.
20% Protein	1500 Cal. of M.E. per lb.

Since some contracts call for the broilers to be delivered at a fixed time, usually around nine weeks, the most profitable rations were calculated for the nine-week feeding period. On this basis for the first three months of 1959, the most profitable ration specification would have been 21 percent protein, 1500 Calories of M.E. per pound followed very closely by 22 percent protein, 1500 Calories. Shortening the feeding period generally has the effect of enhancing the value of the more concentrated and expensive types of rations.

Stability of Optimum Specifications with Varying Prices

Economically optimum specifications for protein and energy, under prevailing prices for the Pacific Northwest during the first quarter of 1959, were similar to present commercial broiler rations. With price variations as they have occurred in the past, how much would the optimum ration specification be shifted?

Under price conditions prevailing in the Pacific Northwest in 1957, the most profitable ration specification for the 10-week feeding period was estimated to be 23 percent protein and 1600 Calories of M.E. (Table 3). This higher protein and energy specification was partly due to higher broiler prices existing in 1957 (21.7¢ per pound) as compared to the first three months in 1959 (18¢ per pound). At least 7 or 8 percent animal fat would be needed to bring the ration to the 1600 Calorie level.

Restricting the feeding period to nine weeks, the most profitable ration specification under 1957 prices was 24 percent protein and 1600 Calories of M.E. as shown in Table 3. This specification was predicted to return a margin over feed cost of about 1.25¢ per bird over that for the more usual 21 percent protein, 1450 Calorie specification. This increased margin of 1.25¢ per bird would represent over $1200 per year for a broiler producer of 100,000 birds annually. For an integrated setup of 100 or more producers, an increased margin of 1¢ per bird becomes even more important

TABLE 8. COMPARISON OF COMPUTED[1] PROFIT POSITIONS FOR VARIOUS FEED SPECIFICATIONS UNDER 1957 AND 1958 PRICE CONDITIONS OF THE PACIFIC NORTHWEST

Ration Specification	Predicted Quantities	Length of Feeding Period	
		Nine weeks	Ten weeks
21% Protein	Lbs. feed per broiler	7.74	9.54
1450 Cal. of M.E./lb.	Lbs. broiler weight	3.05	3.58
	Margin over feed cost per broiler at—		
	1957 prices	30.13¢	33.20¢
	1958 prices	23.26¢	25.12¢
21% Protein	Lbs. feed per broiler	7.61	9.39
1550 Cal. of M.E./lb.	Lbs. broiler weight	3.13	3.67
	Margin over feed cost per broiler at—		
	1957 prices	30.69¢	33.66¢
	1958 prices	23.56¢	25.26¢
21% Protein	Lbs. feed per broiler	7.53	9.30
1600 Cal. of M.E./lb.	Lbs. broiler weight	3.16	3.70
	Margin over feed cost per broiler at—		
	1957 prices	30.86¢	33.75¢
	1958 prices	23.62¢	25.22¢
22% Protein	Lbs. feed per broiler	7.55	9.33
1600 Cal. of M.E./lb.	Lbs. broiler weight	3.20	3.75
	Margin over feed cost per broiler at—		
	1957 prices	31.14¢	34.02¢
	1958 prices	23.66¢	25.20¢
23% Protein	Lbs. feed per broiler	7.57	9.35
1600 Cal. of M.E./lb.	Lbs. broiler weight	3.23	3.78
	Margin over feed cost per broiler at—		
	1957 prices	31.32¢	34.14¢
	1958 prices	23.61¢	25.06¢
24% Protein	Lbs. feed per broiler	7.57	9.36
1600 Cal. of M.E./lb.	Lbs. broiler weight	3.26	3.81
	Margin over feed cost per broiler at—		
	1957 prices	31.38¢	34.11¢
	1958 prices	23.47¢	24.78¢

[1] Computed from average feed costs and broiler prices in 1957 and 1958, respectively.

to the decision maker.

In 1958, broiler prices declined relative to feed ingredient prices. As a result, the optimum specification for the 10-week feeding period declined to 21 per cent protein and 1550 Calories of M.E. per pound as compared to 23 per cent protein and 1600 Calories for 1957. Similarly, the most profitable specification for the feeding period of nine weeks declined to 22 percent protein and 1600 Calories from the 24-percent, 1600-Calorie specification which was optimum under 1957 prices. It is clear that the "best" specification for the ration depends on many factors, the most important being feed ingredient and broiler prices.

Conclusions and Limitations

Examination of the experimental data and the economic analysis supports the initial hypothesis that the optimum nutrient level for rations is an economic as well as a biological question. Ration specifications which economists have tended to assume as "given" or "fixed" are actually also economic variables. Economic analysis of nutritional problems should evaluate returns as well as costs.

Our results are encouraging because they demonstrate the feasibility of applying economic analysis to animal growth data in a more fundamental form than has been done heretofore. Of course, many biological and economic problems require further investigation and study for solution. For example, will various rations composed of different feed ingredients actually give the same results if these various rations all meet presently used specifications? If not, can these differences be attributed to a difference in palatability of various feeds and a corresponding difference in feed consumption? Would further experiments substantiate the profitability of very high energy rations under favorable broiler prices? Difficulties of reconciling results from different experiments still remain despite the use of the more basic protein-energy concept. New experiments are being conducted to answer these and other related questions and should provide a basis for further improvements in answers to the economic problems involved in animal nutrition.

AN APPROACH TO THE EFFECT OF SIZE AND COMBINATION OF ENTERPRISES ON FARM LABOR CONSUMPTION

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SEVERAL methods have been studied for increasing farm labor efficiency and productivity. For example, studies have been made of work simplification and other technological means of decreasing labor input per unit of output. Another way of attaining greater efficiency and productivity is by change in size and combination of enterprises, with technology remaining the same. However, comparatively few have attempted to study any direct effect from size alone, and as far as is known, none have tried to investigate any direct influence of combination of enterprises upon labor requirements per unit of output.

The objective of the present study is to answer the following questions:

1. What is the nature of the relationships between size and combination of enterprises and the labor requirements per unit of output?
2. Are these relationships important enough to justify further study?
3. Can they be analyzed by using time-study data?

Approaches Used Previously

Most studies in this field have been based on survey data. Generally, this approach appears to be of limited value for estimating the relationship between size of enterprise and labor input. The main reason is the lack of sufficient information about factors other than size that influence the labor consumption.

Bernhardsen[1] used data from labor records to compute straight-line regression functions between total working time and number of units in each enterprise or task. Aune and Day[2] used a similar approach, also on the basis of labor records. The main impression from these studies is a large, unexplained variation in labor consumption. However, records seem more suitable for the study of field work than of chore work.

Scoville[3] attempted to synthesize the labor requirement in hog production on the basis of data from time studies. His assumption was that part

* The author expresses gratitude to Lowell S. Hardin and W. H. M. Morris, both of Purdue University, for permission to use the material and for criticisms and suggestions on the analysis. He takes sole responsibility for any errors or omissions.

[1] Bernhardsen, G.: "Tidsforbruket ved arbeidsoperasjoner ute på jordet," *Melding fra Vinterlandbruksskolen*, 1948.

[2] Aune, H. J. and Day, L. M.: "Determining the Effect of size of Herd and Equipment on Dairy Chore Labor," *J. Farm. Econ.*, Aug. 1959.

[3] Scoville, O. J.: "Synthesis of Labor Inputs for Hogs from Time-Study Data," *J. Farm Econ.*, Aug. 1949.

of the working time was fixed for the herd and part variable with the number of hogs. Scoville found a decrease in working time with increasing number of hogs, but he did not test his findings statistically. His classification of work elements appears to be more or less rigid in that the sequence in which work elements occur is not taken into account.

Theoretical Model

Working time required for an enterprise or for tasks can be separated into time that is independent of the volume of output and time that is dependent on the volume. In general, time that does not lead directly to the fulfillment of the objective of a task is independent time. Time for preparing and for cleaning equipment is an example of such work. On the other hand, working time leading directly to the fulfillment of a goal varies with the number of units to be handled and is consequently dependent time.

Under the assumption that each new unit is treated in the same manner and under the same working conditions as the previous one,[4] a constant rate of increase in time is expected as the number of work units increases. This relationship between total working time and work accomplished can be represented algebraically as $Y = a + bx$, where Y is the total time for the enterprise or task, a is the time independent of size, b is the dependent time, which is constant for each additional unit, and x is the number of units of work.

If the total time function is transformed to show time per unit or per animal, this relationship can be expressed as

$$y = \frac{a}{x} + b,$$

where y is the time per unit. This expression shows that labor efficiency rises as the size of operation increases. The rate of increase in efficiency (reduction in hours per unit) is rapid at first but diminishes.

Considering various farm jobs, the existence of work elements that are independent for certain intervals of size but dependent when the entire range is considered may make step functions more realistic than the continuous functions assumed above. After milking for, say, four cows, the farmer has to walk to the milkroom to empty the milk pails. Furthermore, he might have to change the wash water after every ten cows. However, the step effect can be approximated by smooth curves.

The model used in this study assumes no change in technique as size of operation varies. This assumption may be inappropriate for some cases. Improvement of skill with large-size field operations might cause change

[4] Later referred to as "constant technique."

in dependent time; likewise, changes in working conditions. Differences in technique may also cause independent time to vary with size of operation.

The time elements may also vary because of factors not related to technique. Variation in pressure of work is one such factor that is included in this analysis.

Various operations that are common for several enterprises may affect mainly the independent time. For example, in preparing to mix herbicides, approximately the same amount of time is involved whether corn alone is sprayed or another crop is treated at the same time. A combination of two or more enterprises may then decrease the labor requirement per unit as compared to enterprises of the same size operated separately.

It should be stressed that certain time elements are not included in the present analysis of relationship of time to size of operation. Examples are personal time such as talking and resting, or the management which accompanies manual work, such as inspection and particular kinds of decision making.

Source of Data

Data obtained by time studies in the Daily Activity Study, a part of the Purdue Farm Cardiac Project,[5] were used for studying the relationships between combination and size of enterprises and labor requirements. The sample included studies of chore work for market hogs, sows, feeder cattle, beef cattle, machine- and hand-milked dairies, with a total of 32, 36, 46, 14, 3 and 2 complete observations respectively. The studies were obtained during a year on 12 farms in central Indiana. Factors influencing labor requirements, such as layout of buildings, equipment, and feeding systems are assumed to be approximately the same on the farms included. (An exception is dairy cattle, where hand- and machine-milked herds are separated into two technique groups.) Crop enterprises are not considered in this article since the method used in obtaining labor for crops[6] did not adapt itself to this approach.

Classification of Empirical Data

The chore studies were subdivided into two groups on the basis of pressure of field work. The high pressure group usually included the periods from May 7 to July 31 and from September 15 to November 7, corresponding to planting and cultivating of corn and beans, hay-making and harvesting of beans and corn.

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[5] Proceedings of the Farm Cardiac Seminar, Sept. 10-11, 1958. Pur. Univ. Agr. Exp. Sta.

[6] Crop work requirements were recorded in studies of half-an-hour's duration at random throughout a year (work sampling).

TABLE 1. SIMPLE COEFFICIENTS OF CORRELATION BETWEEN TIME REQUIREMENTS AND SIZE OF ENTERPRISE

Enterprise	Correlation Coefficients		
	Dependent Time per Unit	Independent Time	Minimum Value for Significance[1]
Market hogs	0.21	0.20	0.35
Breed sows	−0.53	0.50	0.35
Feeder cattle	0.23	0.25	0.30
Beef cows	0.30	0.35	0.53

[1] Minimum coefficient required to indicate that the relationship is significant at the 5 percent level.

Each observed work element was classified as dependent time, independent time, or personal time and management, as discussed above. The classification was made taking into consideration the complete chore process on the farm.

Some tasks of a preparatory nature which at first sight might be thought to be independent were classified as dependent, e.g. mixing of feed before feeding. The time requirement on this job is obviously related to the size of enterprise. Independent time common for several enterprises was separated out where possible.

Test of Relationship of Time Requirements to Size of Enterprise

The model used assumes that both the dependent time per unit and the total independent time do not vary with size of enterprise. As a test of these hypotheses, simple correlation coefficients were calculated between the time variables and size for each type of enterprise. (The test could not be made for the dairy-cow enterprise because there was only one herd size in each technique group.)

The resulting correlation coefficients are shown in table 1, along with the size of coefficient necessary in each case for the relationship to be significant at the 5 percent level. Except in the case of the breed-sow enterprise, the coefficients are below this level; i.e., in no case are they large enough to refute the hypotheses that the independent time and the dependent time per unit do not vary with size of enterprise.[7]

In the case of the breed-sow enterprise, however, the correlation coefficients imply that the hypotheses of the model are invalid. Presumably it is the assumption of constant technique that is responsible for this. If the

[7] This is not to say, of course, that the test *verifies* the hypotheses. It indicates only that within the limits of the data available there is no strong statistical evidence *against* them. In the subsequent analysis, confidence intervals are used as measures of the significance that may be attached to the relationships developed through use of the model.

TABLE 2. AVERAGE INDEPENDENT TIME, IN MINUTES PER MONTH, FOR INDIVIDUAL ENTERPRISES DURING THE PRESSURE PERIOD

Item	Hogs	Sows	Feeder Cattle	Beef Cattle	Dairy	
					Machine	Hand
Daily chores	366	240	255	282	870	403
Other	12	6	15	2	14	14
Total per month	378	246	270	284	884	417
5 percent confidence interval for the mean						
High	433	313	355	784	1734	510
Low	323	179	185	0[a]	34	324

[a] Actually, −216.

larger herds are accompanied by better layout of buildings or other time-saving features, the statistical result obtained could be expected.

Independent Time for Individual Enterprises

The average monthly labor time that is independent of the size of herd is shown for the various livestock enterprises in tables 2 and 3, with 5 percent confidence limits for the estimates. The confidence limits are extremely wide for beef cattle and machine-milked dairy cows, mainly because of the small number of observations (see "Source of Data," above).

The independent time is higher in non-pressure than in pressure months for all of the enterprises. However, only for hogs and feeder cattle are the differences statistically significant. As these two enterprises are the ones with the greatest number of observations, it is possible that with more observations the differences would have proved significant in the other enterprises.

TABLE 3. AVERAGE INDEPENDENT TIME, IN MINUTES PER MONTH, FOR INDIVIDUAL ENTERPRISES DURING THE NON-PRESSURE PERIOD

Item	Hogs	Sows	Feeder Cattle	Beef Cattle	Dairy	
					Machine	Hand
Daily chores	534	354	435	357	882	546
Other	30	12	30	3	6	6
Total per month	564	366	465	360	888	550
5 percent confidence interval for the mean						
High	612	456	530	508	956	646
Low	516	276	400	212	820	454

Independent Time Common to Several Enterprises

The processing of feed is expected to include an important part of the independent time common for a combination of livestock enterprises.

The same applies to maintenance and new construction of buildings and fences. Independent time in connection with repair operations resulting from deterioration with time could be common to other enterprises as well. Since these types of activity were covered in the work sample and not in the chore-study phase of the Daily Activity Study, quantitative data for them were not available for use in the present study.

Dependent Time for Individual Enterprises

The average dependent monthly labor time per unit for the various enterprises is shown in tables 4 and 5. The monthly dependent time for hogs and dairy cattle (machine-milked group) does not differ between the pressure and non-pressure period. The dependent time for sows and the small, hand-milked dairy herds shows an increase in the non-pressure period, but the difference is not significant at the five percent level. Only for the feeder cattle and the beef cattle enterprises is the difference significant.

The Working Time as Dependent on Size of Enterprise

From the elements for independent and dependent time, the equations showing working time (independent + dependent time) as a function of size can be constructed. As an example, the relationship between size of dairy herd (machine-milked group) and working time required per year is synthesized as follows:

Independent Time per year for the Herd:

4.5 pressure months at 884 minutes	3,978 minutes
7.5 non-pressure months at 888 minutes	6,660 minutes
Total	10,638 minutes
	or 177 hours.

The dependent time per head per year is similarly calculated. The resulting equation showing total time (Y) as a function of number of head (x) is

$$Y = \underset{(104\text{–}249)}{177} + \underset{(39.6\text{–}50.8)}{45.7\,x}$$

where the figures in parenthesis show the 95 percent confidence range.[8]

The corresponding function for hand milking is

$$Y = \underset{(81\text{–}119)}{99} + \underset{(83\text{–}118.8)}{100.9\,x}$$

[8] For farm planning where there is a limited supply of labor, the functions would need to be computed on a seasonal, rather than an annual, basis.

TABLE 4. AVERAGE DEPENDENT TIME, IN MINUTES PER HEAD PER MONTH, FOR INDIVIDUAL ENTERPRISES DURING THE PRESSURE PERIOD

Item	Hogs	Sows	Feeder Cattle	Beef Cattle	Dairy	
					Machine	Hand
Daily chores	4.36	29.16	7.40	2.08	224.0	426.4
Other	0.18	0.42	0.78	0.24	10.8	10.8
Total per month	4.54	29.58	8.18	2.32	234.8	437.2
5 percent confidence interval for the mean						
High	5.70	39.08	9.48	10.83	277	559
Low	3.38	20.08	6.88	0[a]	193	315

[a] Actually, −6.19.

These equations for the dairy enterprise are shown graphically in figure 1. The same functions converted to show the working time per cow per year with varying size of herd are graphed in figure 2.

Similar equations were computed for brood sows and beef cattle:

Sow herd:

$$Y = 64 + 7.85\,x$$
$$(48\text{–}80) \quad (5.92\text{–}9.77)$$

Beef cattle herd:

$$Y = 66 + 2.57\,x$$
$$(26\text{–}122) \quad (1.66\text{–}3.98)$$

For feeder cattle and feeder hogs which are only on the farm for part of the year, the labor consumption will vary with the length of time that they are kept on the farm. It also depends upon the time of year during which the stock is kept—whether during pressure or non-pressure periods. For feeder cattle, the most common practice on the sample farms was to buy

TABLE 5. AVERAGE DEPENDENT TIME, IN MINUTES PER HEAD PER MONTH, FOR INDIVIDUAL ENTERPRISES DURING THE NON-PRESSURE PERIOD

Item	Hogs	Sows	Feeder Cattle	Beef Cattle	Dairy	
					Machine	Hand
Daily chores	4.42	43.73	28.25	18.84	219.2	539.7
Other	0.36	1.32	1.38	0.48	5.4	5.4
Total per month	4.78	45.05	29.63	19.32	224.6	545.1
5 percent confidence interval for the mean						
High	5.71	54.73	35.13	25.35	249	615
Low	3.85	35.37	24.13	13.29	201	475

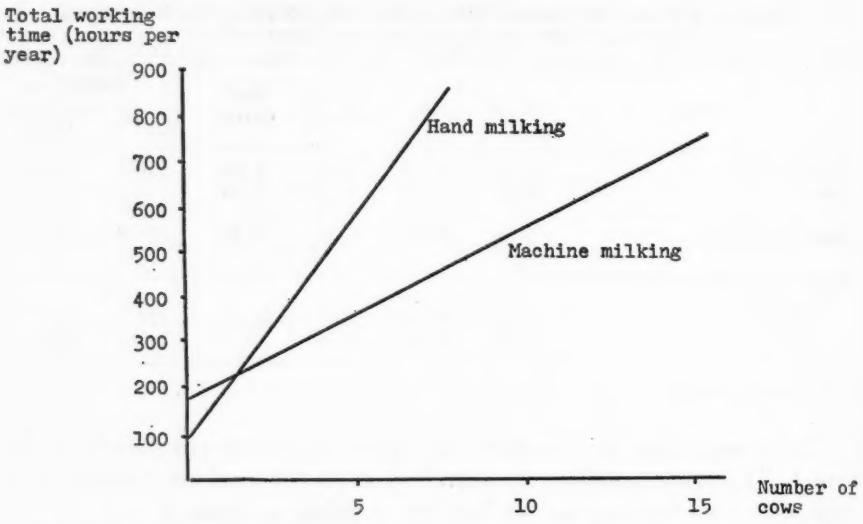

FIG. 1. RELATIONSHIPS BETWEEN TOTAL WORKING TIME AND SIZE OF DAIRY HERD

in the fall before harvest time and keep them on the farm for seven months. Based on the labor data above, such stock would require:

$$Y = 47 + 2.74x$$

(38–56) (2.26–3.24)

Hogs started in April with four months of feeding require:

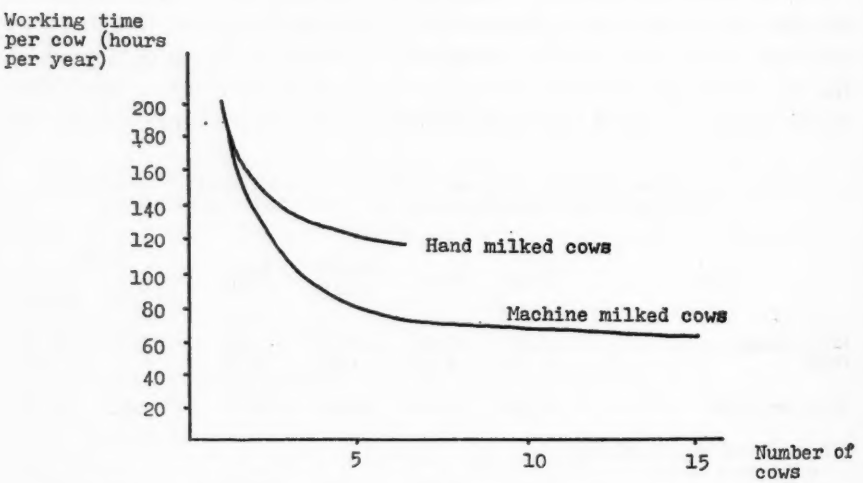

FIG. 2. RELATIONSHIPS BETWEEN WORKING TIME PER COW AND SIZE OF DAIRY HERD

$$Y = 28 + 0.31x$$
$$(25\text{–}32) \quad (0.23\text{–}0.38)$$

For hogs started in September the difference in distribution of pressure and non-pressure periods results in a slight difference in working time.

Personal Time and Management

The individual observations of personal time and management time were averaged for pressure and non-pressure periods, but no statistical test was made. The results appeared to be of relatively limited significance and they are omitted here.

Some Implications of the Independent Time Element

The total labor functions for a 2.5 months' pressure period for hogs and beef cattle are $19 + 0.19x$ and $12 + 0.09x$, respectively.[9] Let us assume that these functions are independent, but add 4 hours of common independent time for the 2.5 months (to cover walking time for common tending, as an example).

If only 44 hours of labor time is available for livestock during this period, the maximum number of beef cows that could be kept is

$$X = \frac{44 - (12 + 4)}{0.09} = 311$$

Alternatively, the number of hogs that could be kept, similarly computed, is 111.

But if any hogs are to be kept at all with beef cows, the maximum time available for cows is reduced by the independent time required by hogs (19 hours). Thus the maximum number of cows has to be reduced from 311 to

$$X = \frac{44 - (12 + 4 + 19)}{0.09} = 100$$

In the same way, if hogs are kept to the limit of labor capacity, a drop from 111 to 47 is necessary before any cows can be kept. Between these two points, 100 cows and 47 hogs, the substitution is of a straight-line nature.

In practice, we do not see such discontinuity in the opportunity curve so clearly, mainly because of the elasticity of the labor supply. The influence of the elasticity of the labor supply could be demonstrated by assuming a greater available total time. By working 19 hours more during this particular period (about 15 minutes per day), hogs could be kept

[9] Including personal time and management.

in addition to beef cows without any discontinuity in the opportunity curve. This is what is likely to occur in practice. On the other end of the curve a still smaller increase in length of the working day would be needed. It is to be recognized, however, that the continuous curve resulting from this increase does not follow the customary definition of an opportunity curve.

As a conclusion, the encouragement to specialization imposed by a fixed time element appears not to be of any great significance for farm planning in this instance.

An Evaluation of the Approach Used

The classification of work directly from the recorded chore process and the calculation of independent and dependent time in separate operations has both advantages and weaknesses. Provided the classification is correct, fewer sizes of herds are required to make reliable estimates than for the conventional method with regression analysis between working time and size of herd. In fact, a single herd, like the group for machine-milked dairy cows in our study, can provide a useful estimate of the parameters in the time functions.

With observations from a complete range of herd sizes for a certain technique, direct regression analysis would be preferable because the problem of classifying independent and dependent elements would then be solved automatically. In practice, such a set of observations is very difficult to obtain.

Tests for linearity for various functions would give information corresponding to that obtained by the statistical tests performed in this research.

The approach used here permits taking account of work elements common to two or more enterprises in deriving functions for enterprise combinations, as well as deriving the functions for the separate enterprises.

Time-study data seem to be generally preferable to survey data or directed labor records for determining labor-size relationships.[10] The results of this study are comparable with results obtained from labor records on much larger samples.

Summary

An approach has been developed to a more thorough study of the relationship between farm labor requirements and size and combination of enterprises by classification of the work elements on the basis of their dependence upon the size of enterprise. Time-study data are used for test-

[10] The costs of making time studies, however, may make use of labor records or survey data more feasible where research funds are limited.

ing some hypotheses concerning the nature of the relationship and to estimate certain variables in chore work. Straight line relationships are found adequate to express total labor as a function of size under conditions of constant technique. Functions have been developed and tested for market hogs, breeding sows, beef cattle, feeder cattle, and dairy cows.

Transformation of the functions to a work-per-unit basis shows decreasing time per unit with increased size of the enterprise. The decline is particularly great with an increase in size of a small enterprise.

As certain enterprises may have some fixed time in common, the time requirement should, other conditions being equal, be higher when an enterprise is run alone than when combined with a complementary enterprise.

On the other hand, the fixed time required by a second enterprise is an incentive to specialization. In the case studied here, however, this effect did not appear to be of any great significance for farm planning.

THE EFFECTS OF DIFFERENT LEVELS OF MANAGEMENT AND CAPITAL ON THE INCOMES OF SMALL FARMERS IN THE SOUTH*

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RECOGNITION of the complexity of the low income problem in U. S. agriculture, especially in the South, has come gradually but surely. Low incomes in the South, as has often been pointed out, involve many families facing educational and motivational handicaps—some with and some without adequate physical resources. For these families, will more capital or land or information or a "better" enterprise combination really be effective in raising incomes, if serious attention is not given to other aspects of the management factor?

Research in a North Carolina mountain county is part of continuing efforts to suggest methods of raising incomes of farmers who depend largely upon income from agriculture. The present study investigates the relations between incomes on the one hand and management and capital on the other by including level of management as an input.

Resource Conditions

Eleven farmers—4 part-time and 7 commercial—were chosen to be as representative of Macon County conditions as possible. Sampling was done on the combination of the farmer and the farm by considering human and physical resources. Particular attention was paid to size and type of farm, soil types, availability of labor from the farm household, availability of other forms of capital, and level of management of the farm operator. Detailed information on Macon County farms was obtained from several sources, while information from all agricultural work-

TABLE 1. RESOURCES AVAILABLE TO SELECTED FARM OPERATORS, MACON COUNTY, NORTH CAROLINA

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TABLE 1. RESOURCES AVAILABLE TO SELECTED FARM OPERATORS, MACON COUNTY, NORTH CAROLINA

Resource	Unit	Farmer Number										
		1	2	3	4	5	6	7	8	9	10	11
Land												
Bottomland:												
Owned[a]	acre	7.0	5.5	15.0	25.0	—	8.0	5.5	45.0	15.0	38.0	25.5
Available to rent in	acre	7.0	—	—	—	—	6.0	—	35.0	—	—	20.0
Upland:												
Owned[a]	acre	3.0	2.5	7.0	28.0	6.0	10.0	10.0	9.0	40.0	23.0	35.0
Available to rent in	acre	5.0	20.0	—	—	—	—	20.0	19.0	—	—	30.0
Pasture:												
Owned[a]	acre	10.0	11.0	20.0	23.0	11.0	—	36.5	12.0	65.0[b]	43.0	47.5
Available to rent in	acre	12.0	20.0	15.0	20.0	25.0	—	25.0	35.0	25.0	25.0	40.0
Labor Available:												
Nov.–Feb. Operator	hour	960	920	1,920[c]	960	960	960	960	1,920[c]	960	960	960
Family	hour	408	648	528	120	312	408	648	325	120	816	408
Hired	hour	—	—	100	100	100	100	—	—	400	960	400
Mar.–Apr. Operator	hour	488	473	976	488	488	488	488	976	488	488	488
Family	hour	207	329	268	61	159	207	329	165	61	414	207
Hired	hour	—	—	50	50	50	50	—	—	200	488	200
May–June Operator	hour	488	473	976	488	488	488	488	976	488	488	488
Family	hour	207	329	268	61	159	207	329	165	61	414	207
Hired	hour	400	400	200	50	999	50	100	200	200	488	999
July–Aug. Operator	hour	496	480	996	496	496	496	496	992	496	496	496
Family	hour	211	335	273	62	161	211	335	168	62	422	211
Hired	hour	400	400	200	50	50	50	100	200	—	496	999
Sept.–Oct. Operator	hour	488	473	976	488	488	488	488	976	488	488	488
Family	hour	207	329	268	61	159	207	329	165	61	414	207
Hired	hour	400	400	200	50	50	50	100	200	200	488	999
Tobacco allotment	acre	0.3	—	—	—	—	—	—	—	—	0.6	—
Christmas tree restriction	acre	—	—	—	—	—	—	—	—	10	—	—
Dairy or beef barns	head	10	—	10	—	10	10	10	25	—	40	—
Pasture restriction	acre	10	11	20	23	11	—	36.5	12	65	43	47.5
Poultry houses	1000 birds[d]	0.4	—	0.4	2.0	1.0	3.5	—	—	—	—	—
Investment Capital												
Readily available	dol.	2,500	1,000	5,000	6,000	2,000	4,000	3,000	5,000	7,500	10,000	4,000
Maximum limit	dol.	8,000	5,000	10,000	12,000	7,000	10,000	10,000	20,000	20,000	25,000	20,000

[a] Can be rented out.
[b] Also owns 89 acres of woodland. Forestry enterprises with woodland resources classified into four categories were considered for this operator.
[c] These include the labor of two men.
[d] One unit = house large enough for 1,000 hens kept for hatching eggs.

ers[1] in the county was obtained and used in making judgments on the distribution of human resources on farms.

Information was obtained on the available resources and the managerial abilities of these farmers. The amount of additional land, labor and capital that each farmer might realistically expect to obtain in his community and the rates he would have to pay for these were determined in consultation with the farmers, county personnel and others in the area. Realistic rates for renting land (*in* and *out*), hiring labor *in* and for off-farm work for the farmer (or member of his family) were also determined. Table 1 shows the resources that were considered to be available to the 11 farm operators. Prices for factors and products where chosen on the criterion of reasonableness in the long run. In particular, their relations to each other were considered; no adjustment was made for the possible effects of increased production in Macon County on product prices or of increased purchases of factors on factor prices.

One of the most important hypotheses being tested in this study was that, at the present stage, the factor most limiting our ability to raise incomes on southern farms is the management ability of farm operators. In order to obtain a partial test of this hypothesis, farm management ability was considered to consist largely in these four factors:[2]

(1) Ability to achieve favorable input-output results efficiently on particular farm enterprises.

(2) Ability to choose the optimum combination (including magnitudes) of farm enterprises.

(3) Ability to determine and obtain control, at lowest cost, over the resources that best complement his own abilities, and to dispose profitably of owned but uncomplementary resources—resource acquisition and disposal.

(4) Ability to market the output profitably.

While each of these factors is quite important to the management of almost any type of farms, the first factor is taken here to be more basic because a farm operator who cannot pass this test of management is not likely to have a good opportunity to pass the other tests. For the purpose of appraising the effectiveness of individual farm adjustments, the management input was explicity recognized by varying the input-output coefficients achievable by individual farm operators on different farm enterprises. Varying input-output coefficients can be used to reflect situa-

[1] Workers consulted included the county staffs of the Agricultural Extension Service, the Agricultural Stabilization and Conservation Committee (ASC), and the Soil Conservation Service, as well as vocational agriculture teachers.

[2] Other important factors would include the farmer's ability to influence his institutional environment favorably (for him). This was neglected for what we hope are obvious reasons.

tions where farm operators are not willing or able to learn, where operators assume that costs exceed the expected increases in incomes, or where operators believe high risks to be associated with increases in purchased inputs or have too little knowledge of the need for significant changes in input-output coefficients.

Input-output relations were dealt with as follows. For each farm enterprise considered to be technically feasible for Macon County, input-output relations for one, two or three levels of management were set up in consultation with research and extension personnel. The number of levels was based upon composite judgment as to the importance of management in the particular enterprise. The more important the role assigned to management, the greater was the number of levels of management assumed. As nearly as possible, the input-output relations for each level of management were based on modal tendencies among farmers, as revealed by discussions with agricultural workers in Macon County.

Input-output relations for the different levels of management were worked out in great detail. Physical relations were developed for each input considered and these were converted into net revenue by factor and product prices developed by giving special consideration to long-run factors and to the relation of these prices to each other. It was recognized throughout that better managers use higher-quality (that is, more productive) inputs and appropriate prices were assigned to each quality of input considered. It was also assumed that the choices of better managers will be nearer the optimum quality for each input required. Generally, better managers can perform required labor and management functions in less time and thus can provide the requisite labor and management for a larger scale of enterprise.

Particular input-output relations were assigned to each farmer in the sample only after lengthy consultation with agricultural workers and depth interviewing of the farmers themselves. Farmers were chosen who satisfied all other sampling restrictions and who seemed to fit the modal tendencies (in input-output relations) for the different enterprises. No farmer was assumed to be universally "good" or "fair" for all enterprises but, for each enterprise considered for him, the input-output relation that seemed uniquely appropriate was chosen regardless of the designation. The composite management level for each farmer was arrived at only after his management level had been estimated for each enterprise considered for him.

The other aspects of management were not handled in the same way as input-output relations. The technique followed implicitly assumed that each farm operator could choose the optimum combination and this will not be the case invariably. The researchers do feel that providing assist-

TABLE 2. INPUT AND OUTPUT ASSUMPTIONS FOR GOOD AND FAIR MANAGEMENT ON A COMMERCIAL LAYER ENTERPRISE

Item	Unit	Level of Management	
		Good	Fair
Laying rate per hen per year	eggs	240	188
Mortality before reaching laying age	per cent	10	20
Culling rates—cumulative	per cent	6	12
Price paid per chick	cents	55	50
Feed per bird to 24th week	pounds	22	26
Feed per bird from 25th week through laying period	pounds	100	103
Net revenue per 500 layers	dollars	1,346	284

ance from outside the farm in choosing the optimum combination is feasible and can be done quite economically. This study did compare income differences between existing and optimum combinations for identical input-output coefficients and resources, and this provides some insight into the importance of choosing the optimum combination.

The third aspect of management—resource acquisition and disposal—was considered but not treated quantitatively as was input-output relations. A subsequent journal article will discuss the importance of this aspect in detail. The fourth factor in management was not considered in this study, implying of course that all farmers could market their products satisfactorily. Thus, this approach to quantifying the management factor is in the nature of a first approximation to measuring real differences in the management input.

Results achieved for two quite different levels of management for the commercial layer enterprise are illustrated in Table 2. A summary of other input-output relations used in the analysis to reflect from one to three levels of management for each enterprise is presented in Table 3. These input-output relations have been standardized to show the resources required to yield $1,000 of net revenue.

The managerial ability of each farmer was determined for each enterprise deemed to be feasible for the mountain area except that no enterprise was considered for a farmer who had a strong aversion to it. Table 4 shows for each farmer the enterprises considered, the management level for each enterprise and the over-all management level.

Farm Size and Management

Linear programming procedures were used to determine optimum resource use combinations and levels of output for at least 6 sets of resource restrictions on each farm. These resource situations for each farmer were as follows:

TABLE 3. RESOURCES REQUIRED TO PRODUCE $1,000 OF NET REVENUE, FOR SPECIFIED FARM ENTERPRISES IN MACON COUNTY, NORTH CAROLINA

Enterprise	Management Level	Acres of Land		Hours of Labor	Investment Capital	Operating Capital
		Cropland	Pasture			
					dollars	
Bottomland corn	Good	11.2		408		61
	Fair	13.2		507		189
Potatoes	Good	3.8		587		698
	Fair	5.1		704		716
Tomatoes	Good	3.1		837		848
Aromatic tobacco	Contract	1.4		897	774	224
Feeder pigs	Good		11.0	269	1,288	1,889
	Fair		21.8	531	2,548	3,827
	Poor		81.6	1,986	9,520	14,809
Brood sows	Good		6.0	663	900	2,841
Grade A dairy	Good	5.0	13.5	1,031	4,920	1,800
Beef herd	Good	5.3	37.2	772	10,089	1,976
Bees	Good			545	4,395	655
Hatching eggs	Good		1.1	532	902	2,473
Commercial layers	Good		1.1	467	743	1,931
	Fair		5.3	2,204	3,510	8,497

TABLE 4. ENTERPRISES CONSIDERED[a] FOR DIFFERENT FARMERS, MANAGEMENT LEVEL OF EACH OPERATOR FOR EACH ENTERPRISE CONSIDERED,[b] AND OVER-ALL MANAGEMENT LEVEL[c]

Enterprise	Farmer Number and Over-all Management Level										
	1	2	3	4	5	6	7	8	9	10	11
	Good	Fair	Exc.	Fair	Fair	Good	Med.	Good	Good	Fair	Good
Alfalfa	**G**	**G**	**G**	**G**	**G**	**G**	**G**	**G**		**G**	**G**
Corn for grain	**G**	**F**	**G**	**F**	**F**	**G**	**F**	**G**	**G**	**F**	**G**
Sweet corn				**F**							
Pickling cucumbers											**G**
Potatoes		**F**		**F**	**F**	**G**	**F**		**G**	**F**	**G**
Tomatoes						**G**		**G**			**G**
Snapbeans	**G**	**F**		**F**	**F**	**G**		**G**			**F**
Peppers		**F**		**F**	**F**	**G**	**F**	**G**		**F**	**G**
Cabbage		**F**							**G**		**G**
Raspberries			**G**		**F**			**G**		**F**	**G**
Strawberries		**F**	**G**	**F**	**F**	**G**	**F**	**G**		**F**	
Aromatic tobacco		**G**									
Burley tobacco	**F**									**F**	
Brood sow	**G**	**F**	**E**	**F**			**G**		**G**	**F**	**G**
Feeder pigs	**G**	**F**	**E**	**F**			**G**		**G**	**F**	**G**
Brood cow for veal calves	**G**	**F**		**F**	**F**	**E**	**F**	**G**	**G**		**G**
Feeder calf		**G**	**G**		**G**	**G**					
Grade A dairy herd								**G**			
Grade C dairy herd							**F**			**G**	
Beef herd	**G**			**F**						**G**	**G**
Beef herd and sheep			**G**		**F**		**F**	**G**	**G**	**G**	
Hatching eggs	**G**	**C**	**G**	**C**	**C**	**G**	**C**	**C**		**C**	
Commercial layers	**G**	**F**	**G**	**F**	**F**	**G**	**F**	**G**		**F**	
Broilers[d]					**C**						

[a] **Boldface type** identifies enterprises that appeared in at least one optimum plan for that farmer.
[b] E means excellent; G, good; F, fair; and C, on contract. The enterprises on contract corresponded to the fair level of management.
[c] Ranking of the over-all management level of the operator from low to high is: fair, medium, good, and excellent.
[d] Four broods annually of 10,000 birds per brood.

IA—own land, own labor, low level of capital: only farm possibilities considered

IB—own land, own labor, high level of capital: only farm possibilities considered

IIA—own land plus land rented in, own labor plus labor hired in, low level of capital: only farm possibilities considered

IIB—own land plus land rented in, own labor plus labor hired in, high level of capital: only farm possibilities considered

IIIA—land rented in and out, labor hired in and out, low level of capital: farm and nonfarm possibilities considered

IIIB—land rented in and out, labor hired in and out, high level of capital: farm and nonfarm possibilities considered

The low level of capital was an estimate of the maximum the farmer could borrow from conventional sources using owned assets as collateral while the high level of capital was an estimate of the maximum the farmer could employ effectively in achieving optimum resource combinations.

Table 5 shows estimates of the family income of the 11 farm families at present and the income that could be attained under the different sets of resource situations assumed in the linear programming analysis.

The role of management may be seen better by classifying farms by acreage of land[3] and management level and working out the (unweighted) average farm income for each category, Table 6. (Two farms were pro-

TABLE 5. ESTIMATES OF PRESENT NET INCOMES AND ATTAINABLE NET INCOMES OF 11 FARM FAMILIES IN MACON COUNTY, NORTH CAROLINA, FOR DIFFERENT RESOURCE SITUATIONS[a]

Farmer Number	Present Income		Income for Resource Situations							
	Farm	Nonfarm	IA	IB	IIA	IIB	IIIA		IIIB	
							Farm	Nonfarm	Farm	Nonfarm
			dollars							
1[b]	1,913	923	6,128	8,063	6,572	7,896	6,357	1,237	7,726	1,054
2	203	728	2,722	3,400	3,505	4,214	3,513	513	4,253	384
3	1,891	2,606	4,827[c]	4,827[c]	4,827[c]	4,827[c]	9,048	—	10,432	—
4[d]	2,633	—[e]	6,575	6,575	6,716	6,716	6,888	994	6,886	1,004
5	984	—	2,421	2,447	2,460	2,485	2,127	808	2,127	808
6	7,906	—	8,305	8,305	8,763	8,763	8,951	165	8,951	165
7	1,076	—	3,491	5,271	3,631	5,305	3,603	637	5,240	373
8[d]	9,412	—	11,755	12,777	—	—	11,988	—[f]	13,592	—[f]
9	2,686	—	5,585	6,009	5,951	6,837	6,962	125	7,764	—
10	2,235	—	4,492	4,492	4,501	4,501	5,130	578	5,130	578
11	3,625	2,080	7,179	7,621	7,675	8,663	6,578	2,080	7,144	2,080

[a] Net revenue to each farm family includes returns to family capital, labor, land, and management.
[b] Assuming hired labor at $0.60 per hour.
[c] Including nonfarm income.
[d] Income for the efforts of two men.
[e] No estimate available of nonfarm income (from saw mill operations).
[f] Nonfarm work not considered.

[3] Small = 17-20 acres of cropland and pasture, medium = 42-76 acres of cropland and pasture, and large = 104-120 acres of cropland and pasture.

TABLE 6. AVERAGE NET FARM INCOME PER FARMER,[a] BY SIZE OF UNIT AND MANAGEMENT LEVEL

Size of Farm[b]	Management Level		
	Fair or Medium	Good or Excellent	All
		dollars	
Small	3,190	8,338	5,764
Medium	4,042	8,048	6,045
Large	5,130	7,440	6,670
All	3,939	7,957	6,103

[a] Incomes from two farms with two full-time male workers each were included but both farmers were counted in each case.
[b] See text footnote 3 for an explanation of the size categories.

grammed with two full-time male workers on each farm, and to obtain an average net farm income per farmer the procedure was to take half the net farm income produced by two workers.)

Although there are other aspects of the data in Table 6 that require explanation, the effect of ability to manage is fairly clear. On small farms, good managers would earn nearly three times as much as fair managers. Good managers on medium-sized farms earned nearly twice as much as fair managers; the increase for good over fair managers on large farms was only 45 per cent.

Transferring a fair manager from a small to a medium farm raised his farm income by 27 per cent, the same percentage by which the farm income of a fair manager on a large farm exceeded his income on a medium farm. Good farmers on large farms received less, on the average, than good farmers on small or medium-sized farms. This paradox can be partially explained by the fact that nonfarm income was higher for good managers on large farms than on medium-sized farms, and because the quantity of owned assets adaptable to the optimum programs under reorganization was greater on medium farms operated by good managers than on large farms operated by good managers. These situations could not be standarized because of the limited number of observations. Further, good farmers on medium or large farms were more prone to rule out management-intensive enterprises (poultry or swine) in favor of enterprises using more of their abundant land resources.

These data indicate that the level of management explains a great deal more of the variation in potential farm income per farmer than does the size of farm measured in acres. Table 7 shows that good managers, if permitted, usually went into management-intensive enterprises (commercial layers and feeder pigs, principally) while fair managers received a

TABLE 7. SOURCES OF INCOME IN THE OPTIMUM PROGRAMS FOR 11 FARMERS IN MACON COUNTY, NORTH CAROLINA, BY SIZE OF FARM AND LEVEL OF MANAGEMENT

Sources of Income	Farm Number										
	2	5	4	7	10	1	6	8	3	9	11
	Farm Size										
	Small	Small	Medium	Medium	Large	Small	Small	Medium	Medium	Large	Large
	Management										
	Fair	Fair	Fair	Medium	Fair	Good	Good	Good	Exc.	Good	Good
	(dollars)										
Poultry[a]		824				7,696	8,493	10,355	8,089	*	*
Swine[a]		*		3,149			*	*	1,849	5,219	3,438
Corn	2,087		1,138	796	1,338			588		1,074	2,205
Aromatic tobacco	2,598	*	*	*	*	*	*	*	*	*	*
Burley tobacco	*	*	*	*	400	200	*	*	*	*	*
Veg. and small fruit[b]		1,213	4,193	1,097	2,592		340	1,561	33	614	1,412
Other activities[c]	*	*	1,105	237	*	*	*	1,197	*	424	*
Land rented in	−210			−39				−350			−83
Land rented out	67	115	500		826	179	185	561	486	978	532
Labor hired in	−289	−25	−50		−26	−349	−67	−200	−25	−545	−388
Off-farm work	384	808	1,004	373	578	1,054	165				2,108
Total farm income	4,253	2,127	6,886	5,240	5,130	7,726	8,951	13,712	10,432	7,764	7,116
Total nonfarm income	384	808	1,004	373	578	1,054	165				2,108
Total family income	4,637	2,935	7,890	5,613	5,708	8,780	9,116	13,712	10,432	7,764	9,224
Investment capital required	1,979	389	6,250	10,000		4,898		8,003	8,595	16,459	10,000
Operating capital required[d]	792	350	875	2,782	1,107	961	1,018	1,298	848	4,464	2,966

* Enterprise not considered on this farm, usually by choice of operator.
a Commercial layers and feeder pigs on 4 farms each; hatching eggs, broilers and brood sows on 1 farm each.
b Potatoes on 5 farms, tomatoes on 3 farms, raspberries on 2, and sweet corn, strawberries, peppers and cabbage on 1 each.
c Includes grade A dairy on Farm No. 8, bees on 3 farms and forest products on 1 farm.
d Maximum cumulative requirement at any time of the year.

much larger proportion of their income from crops such as corn and potatoes. The results suggest that good managers chose enterprises where management is more important while fair managers chose enterprises in which the quality of management is not as important a factor in determining income. Table 8 shows the percentages of income from different sources for fair and good managers and for small, medium, and large farms.

Table 8 shows clearly the tendency of good managers to specialize while fair managers seem to have more diversified operations. Small farms are more likely to depend upon labor-intensive enterprises while medium and large farms tend to obtain more of their income from land-intensive enterprises; as the size of the farm increases, the percentage of income from renting out land increases substantially. More of the income of fair managers was likely to come from off-farm sources than was the case for good managers regardless of the size of farm.

TABLE 8. PERCENTAGES OF TOTAL FAMILY INCOME DERIVED FROM DIFFERENT SOURCES, 11 MACON COUNTY, NORTH CAROLINA FARMS, BY LEVEL OF MANAGEMENT AND BY SIZE OF FARM

Source of Income[a]	All Farmers	Management Level		Size of Farm		
		Fair	Good	Small	Medium	Large
	per cent	*per cent*			*per cent*	
Commercial layers, hatching eggs and broilers	41.3	3.1	58.7	66.8	49.0	0
Feeder pigs and brood sows	15.9	11.8	17.8	0	13.3	38.1
Corn	10.8	20.0	6.6	8.2	6.7	20.3
Potatoes	9.4	28.0	1.0	4.4	10.1	14.1
Other vegetables and small fruits	5.8	6.0	5.7	1.7	8.2	6.2
Aromatic tobacco	3.0	9.7	0	10.2	0	0
Bees	1.8	5.0	0.4	0	3.6	1.0
Grade A dairy	1.4	0	2.0	0	3.2	0
Burley tobacco	0.7	1.5	0.3	0.8	0	1.8
Forest products	0.2	0	0.3	0	0	0.9
Land rented in	−0.8	−0.9	−0.7	−0.8	−1.0	−0.4
Land rented out	5.2	5.6	4.9	2.1	4.1	10.3
Labor hired in	−2.3	−1.5	−2.7	−2.9	−0.7	−4.2
Off-farm work	7.6	11.7	5.7	9.5	3.5	11.9
Total farm income	92.4	88.3	94.3	90.5	96.5	88.1
Total off-farm income	7.6	11.7	5.7	9.5	3.5	11.9
Total family income	100.0	100.0	100.0	100.0	100.0	100.0
Dollars of additional investment capital per dollar of total family income	0.78	0.70	0.81	0.29	0.87	1.16
Dollars of additional operating capital per dollar of total family income	0.20	0.22	0.20	0.12	0.15	0.38

[a] See footnotes to Table 6.

Management as Related to Capital and Optimum Enterprise Combination

A final effort to assess the role of management in low agricultural incomes involved two questions:

1. Would a change in the management level (with all other restrictions constant) affect the optimum enterprise combination? How much effect does the failure to change the enterprise combination have on expected net incomes?
2. Would a change in the management level and capital level with other restrictions constant affect the optimum enterprise combination? How much effect does the failure to change the enterprise combination have on expected net incomes?

These questions were analyzed by studying one small farm situation. Under all resource situations (IA, IB, IIA, IIB, IIIA, and IIIB) raising the management level changed the optimum product mix (enterprise combination). With the high capital level and most flexible resource situation (IIIB), the optimum product mix for better management involved the addition of two new enterprises, reductions in pasture land rented out and cropland rented in of approximately 50 per cent, changes in the distribution of labor hired out and about a 40 per cent reduction in the amount of labor hired in.

Keeping the optimum organization for fair management, but moving from the enterprise input-output relations for fair management to the input-output relations for good management increased expected net revenue by only $625. At the same capital level, making the additional change to the optimum enterprise organization for good management (with good management input-output relations) increased expected net income by more than $4,200 (note row 8, columns 4 and 5, in Table 9).

This illustration also indicates a high degree of complementarity between capital and management levels. At the fair management level, increasing the investment capital to the optimum had the effect of increasing the expected net revenues by $611 to $707. At the good management level, the same increases in investment capital increased annual net revenues by $3,737 to $4,732 (compare columns 1 and 2, Table 9).

Summary

An analysis of income opportunities facing farmers in a low-income, mountain county in North Carolina sheds light on the relative efficiency of measures designed to raise the low incomes of rural people. Linear programming techniques were used in the analysis. Results indicate that the ability to manage may be the most important single determinant of po-

TABLE 9. INCOME CHANGES FOR A SELECTED FARM WHEN MANAGEMENT AND INVESTMENT CAPITAL LEVELS ARE ADJUSTED AND WHEN CHANGES IN OPTIMUM ENTERPRISE COMBINATIONS ARE CONSIDERED

Resource Situation	Net Revenue with Optimum Enterprise Combination for—		Increase in Net Revenue with Change from Fair to Good Management—	
	Fair Management	Good Management	Keeping Optimum Enterprise Combination for Fair Management	Changing to Optimum Enterprise Combination for Good Management
	(1)	(2)	(3)	(4)
	dollars			
I. Farm possibilities with own land and own labor				
A. Invest. cap. at $1,000	2,722	3,285	517	563
B. Invest. cap. at $5,000	3,400	8,017	3,480	4,617
Increase from A to B	678	4,732	—	—
II. Farm possibilities with own land plus land rented in and own labor plus labor hired in				
A. Invest. cap. at $1,000	3,505	4,491	688	986
B. Invest. cap. at $2,876	4,212	8,452	1,373	4,240
Increase from A to B	707	3,961	—	—
III. Farm and nonfarm possibilities with land rented in and out and labor hired in and out				
A. Invest. cap. at $1,000	4,026	5,143	705	1,117
B. Invest. cap. at $1,979	4,637	8,880	625	4,243
Increase from A to B	611	3,737	—	—

tential farm income, and may offer the most logical starting point for overcoming low incomes. Moreover, there is a high degree of complementarity between management and capital levels. Changes in management and capital levels also change the optimum product mix. The greatest increases in net revenue will be achieved when the ability to manage is enhanced, available investment capital is increased, and favorable attitudes toward using the optimum quantities and qualities of resources are developed.

These findings seem to imply that farmers (actual or potential) in low income areas need to have a much better general education[4] and that adult education designed to raise management ability will probably have to be more detailed and intensive than has usually been the case. If the ability of low income farmers to manage can be raised substantially, it

[4] It seems to be no accident that states with highest proportion of their population living in rural areas also have the lowest percentage of adults who have completed the eighth grade.

may be conjectured that favorable attitudes toward resource adjustment will be much easier to instill, and capital and other resources will be much more readily available to them.

These results also indicate that, if resource adjustment studies of typical farm situations are to be used to estimate aggregate adjustments or to make action recommendations to farmers, the management input should be included as an explicit restriction.

LINEAR PROGRAMMING AND ECONOMIES OF SIZE*

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THE authors are concerned that linear programming recommendations to farmers often include more enterprises than make good sense. One reason recommendations may err in the direction of too many enterprises is that the usual programming methods do not allow for economies of size[2] within particular enterprises. This is an attempt to improve or extend linear programming techniques as tools in practical farm management. The procedure followed is to: (1) discuss some factors that may cause economies of size in agriculture and how specific economies of size might be formulated to fit them into linear programming; (2) examine several techniques for solving linear programming problems when economies of size are present, and (3) briefly present an example.

Economies of Size

Factors which cause economies of size in agriculture may be either external or internal to the firm. External factors are usually beyond the control of the single farm manager, and will not be discussed here. The following internal factors appear to be important sources of economies of

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[1] This article is developed from Harald Giaever's M.S. Thesis, "Farm Programming and Economies of Size," North Carolina State College Library, Raleigh, N. C., 1958. The authors gratefully acknowledge the helpful criticism and suggestions of C. E. Bishop, W. W. McPherson, Anthony Stemberger of North Carolina State College, Robert Hutton and Robert McAlexander of Pennsylvania State University and Peter Wegner of Massachusetts Institute of Technology. We claim sole credit for any errors or omissions.

[2] The term "economies of size" is commonly used in connection with cost functions and indicates that the average total cost decreases as the level of output of a commodity increases. See, for example, John Hopkin, "Economies of Size in Cattle Feeding Industry of California," *J. Farm Econ.*, 40:417-429, May 1958. Often, these cost decreases need not be explained in terms of specific inputs; however, it is clearly necessary to formulate economies of size in terms of specific inputs or prices if they are to be fitted into the programming model.

For the purpose at hand, economies of size may occur with respect to the revenue function or with respect to any of the resource equations in linear programming. *Economies of size with respect to a single enterprise exist if, as volume of output is increased, the variable net revenue from the enterprise increases more than proportionally to volume of output, or the input requirement for any limited input increases less than proportionally to volume of output.*

"Economies of size" means virtually the same thing here as "economies of scale" does in the excellent treatment of this and related programming problems by Harry M. Markowitz and Alan S. Manne, "On the Solution of Discrete Programming Problems," *Econometrica*, 25:84-110, Jan. 1957.

size: (1) specialization of labor, (2) management, (3) circumference-area-volume relations, (4) market economies, and (5) fixed charges or set-up times associated with inputs.

It is difficult to see how either specialization or management may be explicitly included in farm programming at the present time. Though specialization of labor is often cited as an explanation of economies of size in industry, examples are much less obvious in agriculture. Limited benefits from specialization are obvious in such functions as dairying, egg gathering and washing, and harvesting some crops. Little empirical effort has been directed explicitly at measuring economies from this source. Even less attention has been given to defining and measuring economies in management and the learning processes.

Economies that are associated with circumference-area-volume relationships are easy to describe mathematically. For example, labor and costs associated with fencing are approximately proportional to the square root of the area enclosed. Such nonlinearities could be handled in linear programming by substituting coefficients that correspond to the level of enterprise expected, as described in Method B below.

Market economies may be very important in some agricultural commodities. These occur when the firms with which farmers deal prefer to buy and sell in large quantities. Sometimes quantity discounts are explicitly stated and can be easily formulated into a mathematical model. Where exchange takes place as a barter between individuals, as is often the case in feeder-stock sales, market economies may be very important, yet impossible to formulate. When lump sum charges are associated with sales, such as annual dues or travel expenses to a particular sale, market economies become a special case of fixed charges.

The term "fixed charges" is used here to identify enterprise costs or inputs that are zero if the enterprise is not included in the program, but are positive and independent of volume if the enterprise is included in the program. Fixed charges or input requirements often are described as "set-up times" in the case of labor. The authors feel that these fixed requirements are one of the most important sources of economies of size in farming. Fixed charges are also easy to formulate in a mathematical way.

Handling Non-Linearities in Programming

Consideration of fixed input requirements need not carry us out of the realm of "linear" programming. Conventional linear programming is based upon a simple linear input-output relationship of the type $y = kx$, which can be described as a straight line through the origin. A slightly more complicated linear function, $y = k_1 + k_2x$, includes a constant term k_1. In order to describe fixed charges, this linear function with a constant

term must have a side condition stating that the constant term drops out whenever $y = 0$.[3] Modification of the linear programming procedure to take into account this mathematical type of economy of size is fairly simple. Methods C and D below are designed to incorporate fixed charges and inputs into the revenue and resource equations, respectively.

In a conventional linear programming problem there is usually one optimum, and the simplex procedure leads progressively to it from lower to ever higher incomes (i.e. the feasible area in vector space is convex). The optimum occurs at a corner value (a vertex) such that if n products are produced, n resources are exhausted. With diseconomies of size, there is still only one optimum (the feasible area in vector space is still convex) and the programming technique with modifications will lead to it, but the optimum need not fall at a vertex. In fact, diseconomies, or diminishing returns to an input, suggest that the variable input service in question be used on a combination of two products. Economies of size, on the other hand, lead to many local optima, each one at a vertex, and the customary programming procedure provides no method of moving from lower to higher local optima. A complete solution of the economies of size problem requires a technique for choosing the highest optima. We will not offer such here, though we do present a way of comparing one optimum with adjacent local optima.

Four methods for handling non-linearities in linear programming will be outlined. Only the first method formulates the problem in such a way that the simplex procedure will give a solution; however, it will work only for diseconomies. The other methods employ adjustments in the final tableau and apply only to economies of size problems. They are versatile, but costly in terms of man hours. Methods A and B offer nothing that is original but provide contrast for the others.[4]

Two modifications of the conventional simplex procedure will facilitate the presentation that follows. These are: standardization as described by Waugh and Burrows[5] and later by Boles[6] and computation through the

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[3] This definition of fixed charges is offered by Warren M. Hirsch and George B. Dantzig in "The Fixed Charge Problem," *Rand Paper* P-648, Rand Corp., Santa Monica, Dec. 1954.

[4] See also: Earl O. Heady and Wilfred Candler, *Linear Programming Methods*, Ames, Iowa: Iowa State Coll. Press, 1958, pp. 220-226; Robert Dorfman, Paul A. Samuelson and Robert M. Solow, *Linear Programming and Economic Analysis*, New York: McGraw-Hill, 1958, pp. 194-196; and Harry M. Markowitz and Alan S. Manne, *op. cit.*

[5] Frederick V. Waugh and Glenn L. Burrows, "A Short Cut to Linear Programming," *Econometrica*, 23:18-29, Jan. 1955.

[6] James N. Boles, "Short Cuts in Programming Computations," *J. Farm Econ.*, 38: 981-990, Nov. 1956.

inverse matrix.[7] We are assuming an elementary familiarity with linear programming; however, a brief word of explanation about these modifications may be worthwhile. Here, standardization means that all resources and outputs are coded to the same value, say 1, such that resource coefficients give the proportion of a resource needed to produce a one dollar unit of output. Standardization is performed by dividing all elements in each row of a conventional simplex tableau by the resource limitations and all elements in each column by the net income per unit of output. The matrix algebra that pertains to linear programming cannot be repeated here but the following definitions based on use of the inverse matrix may facilitate the discussions.

A is a matrix of n rows with $n + m$ column vectors each representing a process, either artificial, disposal or structural.

B is an $n \times n$ matrix consisting of the n vectors that are in the basis.

w_j is an n-dimensional vector of any tableau corresponding to the a_j vector of A. It expresses the a_j vector as a linear combination of the vectors in the basis such that $w_j = B^{-1}a_j$.

S is a resource vector of dimension n giving the available amount of each restrictive resource.

x is a program vector of dimension $n + m$ giving the level of each of the processes.

x_B is the part of x consisting of the n positive elements corresponding to the elements in the basis such that $x_B = B^{-1}s$.

Method A: Formulation of a Nonlinear Problem by Linear Approximations

If the revenue functions or the resource equations are nonlinear, each enterprise can be broken down into a series of processes. Restrictions are placed on each process so that it may be used only within its proper range. As long as there are diseconomies of size, no process will be included in the program without all processes describing lower levels of the same enterprise being included in the program. In cases where there are economies of size, the simplex criterion will tend to bring processes representing the highest levels of output in first. For this reason, method A is not suitable for economies of size.

Example A: An example of this method is now presented mainly so that we can compare it with method B which does work for economies of size. We assume a planning situation with two enterprises, E_1 and E_2, and two

[7] Harvey M. Wagner, "A Comparison of the Original and Revised Simplex Methods," *Operations Res.*, 5:361-369, June 1957.

restrictions R_3 and R_4. One enterprise, E_1, has constant returns to size, while the other has diseconomies of size in one factor requirement. The problem is as follows:

c_j		1	1
	Res.	E_1	E_2
R_3	1	.15	h'
R_4	1	.25	.10

Input requirements for enterprise E_2 with respect to resource R_3 are given by $h = .1x_2 + .025x_2^2$. This continuous function may be represented approximately by a series of "marginal" linear coefficients. For example, the linear coefficients are computed in this way for the interval $x_2 = 2$ to $x_2 = 3$:

$$\text{for } x_2 = 3,\ h = (.1)(3) + (.025)(3^2) = .525$$
$$\text{for } x_2 = 2,\ h = (.1)(2) + (.025)(2^2) = .300$$
$$\text{Increase between } x_2 = 2 \text{ and } x_2 = 3 = .225$$
$$h' = \text{average increase} = \frac{.225}{1} = .225.$$

If computed in this way, the linear segments always will lie inside the real curve for all values of x_2 except at the corners. Hence, the resulting income will be slightly less than the real optimum.

The problem may now be formulated as a linear programming problem. The initial tableau (disposal vectors omitted) is given below. Enterprise 2 is represented by processes $P_2, \ldots, P_6$. Resources 3 and 4 are represented by P_7 and P_8 respectively.

Initial Tableau:

	P_0	P_1	P_2	P_3	P_4	P_5	P_6
P_7	1	.15	.125	.175	.225	.275	.325
P_8	1	.25	.10	.10	.10	.10	.10
P_9	1		1				
P_{10}	1			1			
P_{11}	1				1		
P_{12}	1					1	
P_{13}	1						1

If this problem is solved by simplex computations, the optimum program contains $x_1 = 2.6976$, $x_2 = 1$, $x_3 = 1$, $x_4 = 1$, and $x_5 = .2559$. The out-

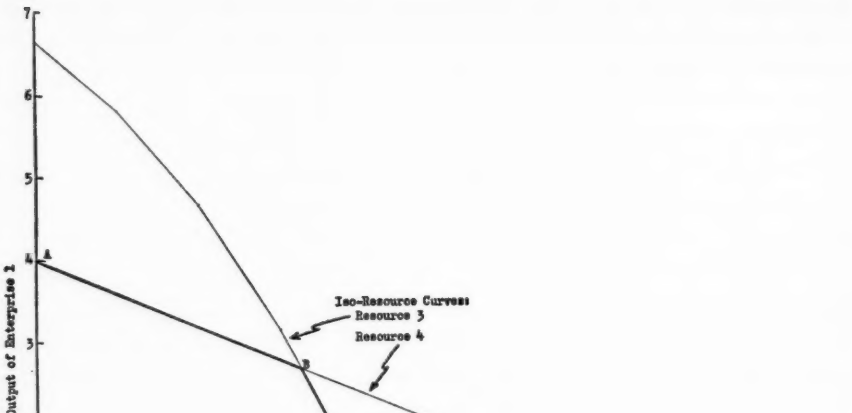

FIG. 1. AN ILLUSTRATION OF THE PRODUCTION POSSIBILITIES FOR EXAMPLE A IN WHICH LINEAR SEGMENTS ARE USED TO APPROXIMATE DISECONOMIES OF SIZE FOR RESOURCE 3 IN THE PRODUCTION OF ENTERPRISE 2

put of enterprise 2 is 3.2559 and that of enterprise *1* is 2.6976. The total net revenue is the sum of these figures, or $5.9535. If the output of enterprise 2 is translated into inputs of resource 3 in the quadratic equation above and added to the requirements of enterprise *1*, we find that only .9952 of resource 3 is actually used. This deviation is mainly due to linear approximations and could have been reduced by breaking down enterprise 2 into more processes.

A production-possibility curve for Example A is graphically depicted in Figure 1. Resource *4* yields a conventional iso-resource line allowing production of 4 units of x_1, 10 units of x_2 or any linear combination of these. Resource 3 allows production of 6.67 units of x_1 or 4.64 units of x_2 on the extremes, but is relatively more efficient for outputs between these points due to the diseconomies. This iso-resource curve is approximately described by five linear segments in this example. The heavy line, ABCD, marks the boundary of the production area. The optimum output could be at any one of these vertices, and with the prices assumed it is at B. If the optimum output were to fall at C two products would be produced but only one of the original resources would be used up. Such an optimum would not be possible in conventional programming nor in the methods

described below when there is only one set of coefficients for each enterprise at any one time.

Method B: Substitution of Processes in the Final Tableau

A linear programming problem is normally defined in terms of a finite number of processes. However, it is fully possible to introduce new processes at later stages in the computations, evaluate their profitability relative to the processes in the basis, and substitute any of these new processes for processes in the basis. Substitution of processes provides a simple method of adjusting coefficients to reflect economies of size.[8] The new process employs "average" coefficients as distinct from the "marginal" coefficients used in Example A. The solution can be started with processes corresponding to the levels of the enterprise expected in the program. After the first solution is reached, the resulting level of each enterprise is compared with the level assumed. If any deviations exist for any enterprises, a new process is defined corresponding to a more likely level, and it is substituted for the old one in the basis.

Example B: We assume resources, enterprises and coefficients similar to those in Example A, except that now there are economies of size in the use of input 3 on enterprise 2. Specifically, $H = .25x_2 - .01x_2^2$, is the assumed input for each level of x_2. It is first assumed that $x_2 = 2$. The appropriate average coefficient is

$$a_{3,2} = \frac{H}{x_2} = \frac{.25x_2 - .01x_2^2}{x_2} = .25 - .01x_2 = .23.$$

The initial tableau and the first solution tableau are as follows:

Initial Tableau:

c_j			0	0	1	1	1
		P_0	P_3	P_4	P_1	P_2	P_{2b}
0	P_3	1	1	0	.15	.23	$a_{3,2b}$
0	P_4	1	0	1	.25	.10	.10

First Solution:

1	P_2	2.3531	5.8823	−3.5292	0	1	$w_{2,2b}$
1	P_1	3.0584	−2.3528	5.4112	1	0	$w_{1,2b}$
$z_j - c_j$		5.4115	3.5295	1.8820	0	0	

The resulting level of enterprise 2 is 2.3531 while a level of 2 was as-

[8] As presented here, Method B only allows solutions at vertex points and not along the curved part of a production possibility surface due to diseconomies. Peter Wegner has developed modifications that will handle diseconomies, "Some Non-Linear Programming Solution Procedures," Unpub. M.S. Thesis, Pa. State U. Libr., 1959.

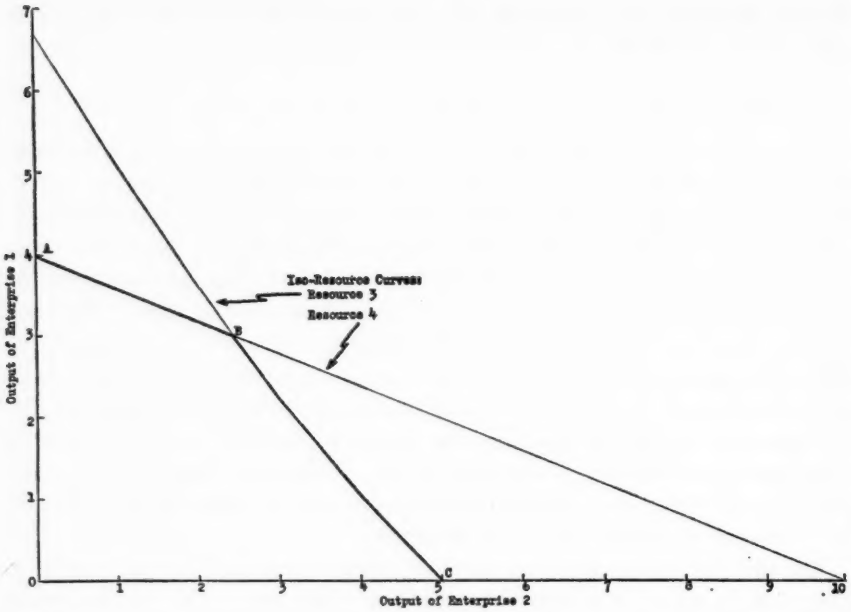

FIG. 2. AN ILLUSTRATION OF THE PRODUCTION POSSIBILITIES FOR EXAMPLE B IN WHICH THERE ARE ECONOMIES OF SIZE IN THE USE OF RESOURCE 3 ON ENTERPRISE 2

sumed. A new process, P_{2b}, can be defined to correspond to a more likely level of enterprise 2. The correct level can be found by trial and error, or in a simple problem of this type, it could be found graphically (at vertex B in Figure 2) or by solving the following equations:

$$a_{3,2b} = .25 - .01x_{2b},$$

$$x_{2b} = \frac{2.3531}{w_{2,2b}},$$

$$w_{2,2b} = (5.8823)(a_{3,2b}) + (-3.5292)(.10).$$

Solving these equations yields a level of $x_2 = 2.4122$. By inserting the correct values of $w_{2,2b}$ and $w_{1,2b}$ in the first solution and then "bringing in" the P_{2b} activity, the following second solution is obtained.

Second Solution:

c_j			0	0	1	1	1
		P_0	P_3	P_4	P_1	P_2	P_{2b}
1	P_{2b}	2.4115	6.0282	−3.6167	0	1.0248	1
1	P_1	3.0349	−2.4115	5.4464	1	−.0100	0
$z_j - c_j$		5.4464	3.6167	1.8297	0	.0148	0

The production possibility curve for Example B is represented by the heavy line ABC in Figure 2. In this case resource 3 yields an iso-resource line that is convex toward the origin. The optimum output could fall at either A, B, or C depending on the prices assumed. The second solution above corresponds to point B. It should be noted that this method, by itself, offers no way of comparing the profit at points B and C. For example, if the net income per units of x_2 were 1.5 instead of 1.0 the total net income would be 6.65 at B and 7.5 at C but the $z_j - c_j$ row of the second solution would not indicate any opportunities to increase income. There is nothing in the linear coefficients that reflects the potential economies of size by moving to point C. The nonlinearity is introduced by changing the coefficients.

Method C: Adjusting Solutions for Fixed Charges

Method C provides a simple test for the profitability of dropping any included activities. The test is especially useful when economies of size arise because of fixed charges. Fixed charges are treated here as savings that are possible if particular processes are not included in the program. The first solution is computed using net revenue functions that do not include the fixed charges. This solution is then examined to see whether the loss incurred if each activity is removed is smaller than the fixed charges saved, so that actual net revenue will increase if the activity is removed.

Example C: A linear programming problem and the first solution are given below. Only the B^{-1}-matrix, the program vector (P_0), and the $z_j - c_j$ row are given for the solution.

Initial Tableau:

c_j		0	0	0	0	1	1	1	1
	P_0	P_5	P_6	P_7	P_8	P_1	P_2	P_3	P_4
P_5	1	1				.31	.34	.11	.28
P_6	1		1			.08	.42	.07	.44
P_7	1			1		.48	.10	.33	.15
P_8	1				1	.11	.13	.45	.08

First Solution:

	P_0	P_5	P_6	P_7	P_8
P_2	1.6084	8.6270	−4.0860	−5.4726	2.5400
P_4	.3887	−8.3320	6.3666	4.9042	−2.5501
P_1	.5601	1.8048	−1.4084	1.4465	−1.2828
P_3	1.5516	−1.4521	.3928	.3555	2.2554
$z_j - c_j$	4.1088	.6477	1.2650	1.2336	.9625

Assume that there is a fixed charge of .1000 for every active enterprise. This sum can be saved for every enterprise that can be dropped from the program. Now, ask whether the loss associated with removing each enter-

prise, and each pair of enterprises, etc., exceeds the fixed charges that would be saved.

In some cases it is very easy to compute the loss incurred by dropping an enterprise and in others it may involve several iterations. For example, P_2 in the first solution may be replaced by either P_5 or P_8. These are the only two activities that can replace it at positive levels. The level at which P_5 replaces P_2 is $\frac{1.6084}{8.6270} = .1864$. The loss in income is the level of the P_5 disposal times the value marginal product of P_5, $(.1864)(.6477) = .1207$. This is clearly less than the loss from P_8 replacing P_2.

The losses from removing each activity can be summarized as follows:

Enterprise dropped	Activities brought in	Loss incurred
P_2	P_5	.1207
P_4	P_6	.0772
P_1[9]	P_2 by P_5 then P_1 by P_7	.1207+.1419
P_3	P_3 by P_8 then P_2 by P_7	.6621+.0256

The only single enterprise that could profitably be dropped is P_4. The increase in income would be $.1000 - .0772 = .0228$. The second solution is now presented in which P_6 has replaced P_4.

Second Solution: P_6 replaces P_4 in first solution

	P_0	P_5	P_6	P_7	P_8	P_4
P_2	1.8578	3.2796	0	−2.3252	.9034	.6418
P_6	.0611	−1.3087	1	.7703	−.4005	.1571
P_1	.6461	−.0384	0	2.5314	−1.8469	.2212
P_3	1.5276	−.9380	0	.0529	2.4127	−.0617
$z_j - c_j$	4.0315	2.3032	0	.2591	1.4692	−.1987

The process may now be repeated by asking whether it is profitable to drop any enterprises from the second solution. The losses associated with removing each activity are as follows:

[9] Note that the removal of P_1 and P_3 is somewhat more difficult than that of the others. In the first solution, positive entries appear in the P_1 row for P_5 and P_7. P_5 involves less loss than P_7. However, if P_5 were used to replace P_1 it would force P_2 into the program at a negative level. As a matter of fact, each replacement is limited by some other enterprise before it is limited by P_1. If P_7 were used to replace P_1 it would force P_4 in at a negative level and it would also cause a negative $z_j - c_j$ value for P_6. In this particular case, P_1 can be replaced by P_7 at a cost of .1419 once P_5 has replaced P_2, leaving P_3 and P_4 in the program. Replacing P_3 by P_8 causes P_2 to become negative; P_2 can then be replaced by P_7.

Enterprise dropped	Activities brought in	Loss incurred
P_2	P_5	1.3045
P_1	P_1 by P_7 then P_6 by P_5	.0661 + .2410
P_3	P_8	.9301

No one of the three processes can be profitably removed, and we are led to accept the program listed in the second solution as the optimum combination of enterprises.

Method C will not always lead to *the optimum.* This test merely allows comparison of one local optimum with some of the adjacent surrounding optima. In the above example, we tested the profitability of each combination of three enterprises against all four enterprises being produced, and we tested the following combinations of two enterprises: *1* and *2*, *1* and *3*, *2* and *3*, *3* and *4*, and *1* and *4* (see footnote 9). We did *not* test the profitability of *2* and *4*, or any of the single enterprises. In a small problem of this type, it is simple to systematically list and eliminate each of the possibilities.

Method D: Adjusting Solutions for Fixed Resource Requirements

Fixed input requirements are often associated with certain processes. If it were known in advance which enterprises would enter a program, the fixed requirements could be deducted from the total resources available before computations started. As a rule, however, it is not known just which processes will enter the program. Yet, it is relatively easy to change the resource vector after the first solution has been obtained. A brief outline of a method for doing this follows:

1. Select a tentative resource vector—based on total amount of available resources and a "best guess" as to how much of the available resources will be used for fixed input requirements.
2. Arrive at a first solution through simplex computations.
3. Adjust the resource vector according to which processes have really entered the program.
4. Arrive at an adjusted program by the matrix multiplication $x_B = B^{-1}s$.
5. Examine whether any elements in the program vector now have become negative. If so, new matrix operations may be necessary, and possibly new changes in the resource vector.
6. Examine the adjusted program to see if it is profitable to drop any included activities thereby saving fixed input requirements.

Example D: We will use the same example as in Method C, except that here we assume that fixed input requirements with respect to resource P_8 make the adjustment necessary. The assumed resource equations are

$$h_{8,1} = .05 + .11x_1,$$
$$h_{8,2} = .10 + .13x_2,$$
$$h_{8,3} = .22 + .45x_3,$$
$$h_{8,4} = .03 + .08x_4.$$

Only that part of the P_8 resource requirement that varies with level of output is included in the initial tableau and first solution above. In this case, we make no deduction in the resource vector before computations start. The first solution shows that all four enterprises are included in the program. The fixed requirement for this program would be

$$.05 + .10 + .22 + .03 = .40$$

Forty per cent of the total available quantity of P_8 is needed to cover fixed input requirements. Since we are working with standardized data, we may find the adjusted program in the third solution by reducing all elements in the column under P_8 in the first solution by 40 per cent, and then summing each row to obtain the new P_0 column. This is identical to $x_B = B^{-1}s$ as a method of finding the new program vector and is much quicker.

Third Solution: First solution adjusted for fixed factor requirements

	P_0	P_5	P_6	P_7	P_8
P_2	.5924	8.6270	−4.0860	−5.4726	1.5240
P_4	1.4088	−8.3320	6.3666	4.9042	−1.5300
P_1	1.0732	1.8048	−1.4084	1.4465	−.7697
P_3	.6494	−1.4521	.3928	.3555	1.3532
$z_j - c_j$	3.7238	.6477	1.2650	1.2336	.5775

It may still be possible to improve the third solution, even though the simplex criterion indicates that the problem is finished. The conventional simplex test does not facilitate movement from one local optimum to another. Because fixed factor requirements may use restrictive factors, consideration of fixed factor requirements may make it profitable to drop a process which was included in the program or to substitute for an included enterprise one with lower fixed factor requirements.

The profitability of dropping each of the enterprises in the third solution should now be tested. Tests show that P_2 is the only process that can be removed with advantage. The direct loss from removing P_2 is found from the third solution to be

$$\frac{.5924}{8.6270}(.6477) = .0445.$$

The fixed factor requirement of P_2 was 10 per cent of total quantity of P_8 available. The gain due to the fixed factor requirement that is saved if P_2 is dropped from the program is .10 multiplied by the value marginal product of P_8. This is found from the first solution to be

$$.10\left[.9625 - \frac{2.5400}{8.6270} \times .6477\right] = .0772.$$

The value marginal product of P_8 in the first solution is .9625; however, this figure changes if P_5 is substituted for P_2 in the basis. The expression inside the brackets is equal to .7718, which is the value marginal product of P_8 after the change of basis (see solution 4). The net result is that the total net revenue will increase .0772 − .0445 = .0327 income units if P_2 is removed from the program.

Removal of P_2 involves two steps. First, the disposal process P_5 is substituted for P_2. The result is presented as the fourth solution which was obtained directly from the first solution. Second, the fourth solution is adjusted for new fixed factor requirements by reducing all elements in column P_8 by 30 per cent and by summing the rows to obtain the adjusted program vector. The result, presented as the fifth solution, indicates a net revenue of 3.7565, which is .0327 more than the income from the third solution, just as predicted.

Fourth Solution: Third solution with P_2 removed

	P_0	P_5	P_6	P_7	P_8
P_5	.1864	1	−.4736	−.6344	.2944
P_4	1.9421		2.4203	−.3812	−.0970
P_1	.2236		−.5536	2.5914	−1.8142
P_3	1.8223		−.2950	−.5657	2.6830
$z_j - c_j$	3.9880	0	1.5717	1.6445	.7718

Fifth Solution: Fourth solution adjusted for fixed factor requirements

P_5	.0981	1	−.4736	−.6344	.2061
P_4	1.9712		2.4203	−.3812	−.0679
P_1	.7679		−.5536	2.5914	−1.2699
P_3	1.0174		−.2950	−.5657	1.8781
$z_j - c_j$	3.7565	0	1.5717	1.6445	.5403

This method may seem complicated. In practice, the tests explained here do not take much time. Often, the results can be judged by inspection, so that the computations are necessary only in borderline cases. Perhaps the reader should be reminded again that these tests for the profitability of dropping each activity do not provide a comparison of the profitability of each local optimum. Since consideration of fixed charges and

economies of size would always reduce the number of enterprises if it does anything, it can be claimed, at least, that these tests are aimed in the direction of the expected movement.

Choice of Method

The method chosen will usually depend on the nature of the deviations from linearity that are involved in a particular problem.

Method A will give approximate solutions to problems involving diseconomies of size. If the diseconomies occur in many of the enterprises a large number of processes will be necessary to reach a solution with reasonably close approximation. The main advantage of this method is that it leaves the problem in a form that is readily solvable by existing machine methods.

Method B will handle any type of economies of size. The solutions arrived at are always more realistic than the solutions obtained by simply ignoring nonlinearities where such exist. However, if several local optima exist, method B provides no way of moving from one local optimum to other local optima yielding higher net revenue.

Method C is suitable when the revenue or net revenue functions are linear with a constant term such that the constant term drops out at zero levels of an activity. The most common cases in agriculture that can be described in this way are expenses for machinery or hired labor that are the same regardless of the level of output.

If the resource equations are linear with constant terms and the constant terms disappear if the corresponding activity is not included in the program, methods B or D can be used. Method B would need some procedure for testing the profitability of dropping activities added to it if it were to be considered as rigorous as method D. Even then, if the trial and error method is used in method B, then method D will normally be more exact and quicker. In situations with many local optima the two methods do not necessarily lead toward the same "optimum" point. In such situations, it cannot be said that one method has a better chance than the other of leading to the higher optimum.

An Example Summarized

Method D was applied to programming a small Norwegian farm. Seven activities were considered with five restrictions including four fixed labor requirements. The method proved quite valuable in selecting among dairying techniques that had different ratios of fixed to variable labor requirements. Also, a case of nonadditive fixed requirements was easily handled—barley and wheat used some of the same equipment. The first solution contained 750 layers, two dairy cows, barley and wheat. In the

final solution the layers were dropped and the dairy herd increased to 8 cows. The improvement in income and realism was sufficient to justify the small added effort.

It is our opinion that instances of fixed input requirements are quite common in agriculture. "Set-up" times that affect limited labor and fixed charges that affect the use of limited capital are perhaps the most common instances. The extra time that is required to apply method D to such situations is quite small when compared with the added element of reality that is obtained in results.[10]

[10] One might ask whether method D can ever be adapted to solution on digital computers. Developments by Dantzig at Rand Corporation, Gomery at Princeton suggest that machine solutions of problems in which activities must enter at integral levels are not far off. George Dantzig, "Solving Linear Programs Integers." *Rand Research Memorandum*, 2209. Ralph E. Gomery, "Outline of an Algorithm for Integer Solutions to Linear Programs," (Unpub. ms., Princeton U., 1958).

CARDINAL UTILITY FUNCTIONS AND MANAGERIAL BEHAVIOR

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THE variables affecting the decision-making process of farm managers have only relatively recently become the subject of serious study in agricultural economics.[1] One of the reasons for this development is that a traditionally price-oriented economic theory of the firm sheds little light on such questions as the following: "Why do some managers adopt new technologies more quickly than others?" or "Why do some farmers prefer risky undertakings such as cash-crop farming or livestock fattening to enterprises with more stable income?" or "Why are some willing to assume large debt burdens while others think 'a mortgage casts a shadow on the sunniest field'?" These and similar questions are of considerable interest in farm management analysis, agricultural extension and, on a broader scale, national agricultural policy, yet they are not easily or sufficiently answered with traditional methods of analysis.

The principal purpose of the present article is to suggest that certain characteristics of cardinal utility functions estimated for individuals according to the method developed by von Neumann and Morgenstern[2] can contribute to the explanation of managerial behavior in situations similar to the ones suggested in the previous paragraph. A review of the literature dealing with utility measurement reveals that the theoretical validity and meaning of the von Neumann-Morgenstern index have been widely discussed, but empirical work which uses the index for purposes of prediction has to date been attempted in only a few instances.[3]

This paper is divided into three parts. In Section 1 we will sketch out some of the theoretical arguments which have been advanced in support of the existence and measurability of cardinal utility functions, Section

[1] See, for example, Great Plains Agricultural Council, *Proceedings of Research Conference on Risk and Uncertainty in Agriculture, Bozeman, Montana, August 10-15, 1953* (Fargo: 1955), 98 p. (N. D. Agr. Expt. Sta. Bul. 400, Great Plains Agr. Council Pub. No. 11.) See, also, Glenn L. Johnson, "The Friedman-Savage Utility Hypothesis in the Interstate Managerial Study," *J. Farm Econ.*, 37:1110-14, Dec. 1955. See, also, related articles by various authors in the section "Progress and Problems in Decision-Making Studies," A. W. Epp, Chairman, *J. Farm Econ.*, 37:1097-1125, Dec. 1955.

[2] John von Neumann and Oskar Morgenstern, *Theory of Games and Economic Behavior* (Princeton: Princeton Univ. Press, 1944), p. 625.

[3] See, for example, Frederic Mosteller and P. Nogee, "An Experimental Measurement of Utility," *J. Pol. Econ.*, 59:371-404, Oct. 1951.

W. Edwards, *Experiments on Economic Decision Making in Gambling Situations* (Ann Arbor: Univ. of Mich., Nov. 1952). (Seminar on the Application of Mathematics to the Social Sciences.) Mimeo.

II will show how we have attempted to estimate utility functions empirically, and in Section III we will attempt to interpret certain characteristics of farm managers in terms of the utility functions estimated for them.

I. *Existence and Measurability of Cardinal Utility Functions*

The von Neumann-Morgenstern hypothesis

Cardinal measurement[4] of any quantity, be it temperature, weight, pressure or, in this case, utility, presupposes the presence of a measuring device which is unique except for origin and unit of scale. For example, the Fahrenheit scale for the measurement of temperature is related to the Celsius (centigrade) scale by the linear equation

$$F = 32 + 9/5C, \tag{1}$$

the former being merely a linear transformation of the latter and, in general, the measurement of temperature in terms of a certain expanding (and contracting) gas is unique up to a linear transformation.

Von Neumann and Morgenstern and others[5] have attempted to show

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[4] A mathematical definition of "cardinal" measurement is given by Glenn James and Robert C. James in *Mathematics Dictionary* (New York: D. Van Nostrand Co., 1949), p. 38: ". . . two sets are said to have the same cardinal number if their elements can be put into one-to-one correspondence with each other." This is in contrast to "ordinal" measurement, which refers to a ranking in terms of relative magnitudes. "It is twice as hot today as it was yesterday" presupposes a cardinal; "it is warmer today than it was yesterday" merely an ordinal scale. When cardinal measurement is thought of simply in terms of its mathematical definition, it becomes clear that it does not mean measurement of any "intrinsic" element (as, for example, personal satisfaction in the case of utility measurement). Confusion of the terms "cardinal" and "intrinsic" has led to the common belief that, since satisfactions per se are not measurable, the ordinal view of utility measurement must be the alternative. W. J. Baumol in a recent article entitled "The Cardinal Utility Which is Ordinal," *Economic Journal*, 68:1-6, Dec. 1958, although contributing much to a clarification of the issues involved, also does not appear to make a sufficiently clear separation between the terms "cardinal" and "intrinsic" and therefore is again led to the belief that cardinal utility is ordinal after all. We will come back to this problem later in this paper.

[5] See, for example, A. A. Alchian, "The Meaning of Utility Measurement," *Amer. Econ. Rev.*, 43:26-50, March, 1953.

Franz Alt, "Ueber die Messbarkeit des Nutzens," *Zeitschrift fuer Nationaloekonomie*, 7:161-169, 1936.

W. E. Armstrong, "The Determinateness of the Utility Function," *Econ. J.*, 49: 543-567, Sept. 1939.

William J. Baumol, "The Neumann-Morgenstern Utility Index, An Ordinalist View," *J. Pol. Econ.*, 59:61-66, Feb. 1951.

Daniel Bernoulli, "Exposition of a New Theory on the Measurement of Risk," transl. from Latin into English by Dr. Louise Sommer, *Econometrica*, 22:23-36, Jan. 1954.

D. Ellsberg, "Classic and Current Notions of 'Measurable Utility,'" *Econ. J.*, 64: 528-56, Sept. 1954.

Milton Friedman and L. J. Savage, "The Utility Analysis of Choices Involving Risk," *J. Pol. Econ.*, 56:279-304, Aug. 1948. (footnote continues)

that under certain assumptions there exists a measure of "utility" which is (just like the ones for temperature or weight) unique except for origin and unit of scale. In particular, von Neumann and Morgenstern have advanced the following hypothesis: *People choose among uncertain prospects as if they were maximizing the expected value of these uncertain prospects.* After stating certain basic assumptions, they have proven mathematically that the expected value of uncertain prospects provides an index for the measurement of utility which is unique up to a linear transformation. Therefore, if this index predicts actually observed behavior accurately and repeatedly fails to be contradicted, then it has been demonstrated that utility is measurable in the same sense as temperature, weight or any other quantity for which a similar measure exists. Unfortunately, only a few empirical applications designed to test the predictive power of the index have been undertaken so far, and it is consequently difficult to appraise the reliability of the suggested hypothesis at this time.

Before we discuss in greater detail what is meant by measurable utility, it is useful to make the following observation: The index suggested for the measurement of utility says nothing about the amount of "satisfaction" which is experienced by an individual as a result of obtaining a certain good. Alt[6] has pointed out in this connection that "one has to distinguish between the 'actual' measurability of utility (referring to the inner satisfaction which derives from owning a good) and the 'substitutive' measurability of utility which merely implies that a uniquely measurable quantity can be associated with utility. However, this distinction appears to be quite unnecessary if one considers that all quantitative measurements which can be found or which are conceivable in either scientific or applied work are 'substitutive' measurements." To illustrate, if I should choose to sit down on a hot stove whose plate has a temperature of, let us

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Friedman and Savage, "The Expected Utility Hypothesis and the Measurement of Utility," *J. Pol. Econ.*, 60:463-74, Dec. 1952.

Oscar Lange, "The Determinateness of the Utility Function," *Rev. Econ. Studies*, 1:218-25, 1934.

Harry Markowitz, "The Utility of Wealth," *J. Pol. Econ.*, 60:151-58, April 1952.

Jakob Marschak, "Rational Behavior, Uncertain Prospects and Measurable Utility," *Econometrica*, 18:111-41, April 1950.

Gerhard Tintner, "A Contribution to the Non-Static Theory of Choice," *Q. J. Econ.*, 56:278, Feb. 1942.

William Vickrey, "Measuring Marginal Utility by Reactions to Risk," *Econometrica*, 13:319-33, Oct. 1945.

For additional relevant references, see R. G. D. Allen, *Mathematical Economics* (London: Macmillan and Co., Ltd., 1957), in particular the references at the end of chap. 19, pp. 692-693.

[6] Alt, *op. cit.*, p. 168. This passage was translated from the German by the junior author.

say, 300 degrees, then a thermometer attached to this plate measures in no way the unpleasant sensation I will have experienced, although I should, and next time undoubtedly will, associate these two otherwise unrelated quantities.

Consequently, the "utility" measured with the von Neumann-Morgenstern index has no immediate relevance for welfare economics and at this point merely represents a concept to be used in the formulation of a scientific theory of choice.[7]

Construction of the utility function

Consider entities $A, B, C, D, \ldots$, and for purposes of exposition assume that these entities represent different prospective incomes.[8] A may be \$300, B may be \$200, and C may be \$100; assume that among these three entities relation (2) holds.[9]

$$A \geq B \geq C. \tag{2}$$

Let $U(C)$ represent the utility of C and assign to it arbitrarily the value 1; let $U(B)$ represent the utility of B and assign to it arbitrarily the value of 2;[10] the problem is to determine the utility of A, $U(A)$.

Von Neumann and Morgenstern now suggest that if an individual with a perference pattern such as the one in relation (2) above were confronted with the proposition: take either B for certain or an uncertain prospect composed of A with probability p and C with probability $(1 - p)$, then there exists for this individual some p, $(0 < p < 1)$, which would make him indifferent between the certain prospect of B and the uncertain prospect composed of A with probability p and C with probability $1 - p$ such that equation (3) holds.

$$U(B) = pU(A) + (1 - p)U(C). \tag{3}$$

If such a p exists, and under the von Neumann-Morgenstern assumption it must, and the individual is able to specify this p, then $U(A)$ can be determined uniquely, since from equation (3) it follows that

$$U(A) = \frac{U(B) - (1 - p)U(C)}{p}. \tag{4}$$

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[7] Friedman and Savage, "The Expected Utility Hypothesis . . .," *op. cit.*, p. 473.

[8] This part of the exposition follows in a condensed form the one presented by Alchian, *op. cit.*, p. 38.

[9] In the following exposition $A > B$ stands for "A is preferred to B," $A = B$ means the person is indifferent between A and B, and $A < B$ means "B is preferred to A."

[10] The origin is fixed at C, $U(C) = (100, 1)$ and the unit of measurement is $U(B) - U(C) = 1$.

TABLE 1. HYPOTHETICAL GAIN AND LOSS SITUATIONS USED FOR THE ESTIMATION OF UTILITY FUNCTIONS

Situation Number	Amount of Possible Gain or Loss	Probability of Gain or Loss Occurring[a]	Amount of Payment and Types of Odds[b,c]		
			MF	F	UF
Gain Situations					
	Dollars			*Dollars*	
1	500	1/20	10	25	40
2	1,000	1/40	10	25	40
3	5,000	1/200	10	25	40
4	10,000	1/400	10	25	40
5	25,000	1/1000	10	25	40
6	50,000	1/2000	10	25	40
Loss Situations					
7	100	1/4	10	25	40
8	500	1/20	10	25	40
9	1,000	1/40	10	25	40
10	10,000	1/400	10	25	40
11	25,000	1/1000	10	25	40
12	50,000	1/2000	10	25	40

[a] The range of objective probabilities from 1/2000 to 1/20 for the gain situations and 1/2000 to 1/4 for the loss situations was kept to a minimum to try to avoid the possible confounding effects of the utility attached to probability distributions. *Cf.* W. Edwards, *op. cit.*

[b] The range of payment or stakes from 10 to 40 dollars for both sets of situations was intended to avoid the possible offsetting disutility of this loss. Thus, it was assumed that the disutility of the payment was constant over that range. *Cf.* E. W. Thrall, C. H. Combs, and R. L. Davis, *Decision Processes*, New York.

[c] The three subcolumns under this heading correspond respectively to more than fair, just fair, and unfair odds. All 10 dollar payments are MF; 25 dollar payments, F; and 40 dollar payments, UF. Variations in the size of the payment rather than manipulation of the probabilities as such was considered to be a more easily comprehended method of varying the effective probabilities of winning (losing).

mine if and where along the scale of increasing possible gains or losses the individual has switched from saying "Yes" to saying "No" or vice versa. Whenever such a switch occurs and provided certain other consistency criteria are met, there is reason to assume that the interval so bracketed will contain that value for p which would make the individual indifferent between the certainty of having his present income (wealth) and a chance combination of winning the prize with probability p or losing the payment with probabiility $(1 - p)$.

More formally, if:

B = an individual's present income position,

A = the position of having a certain amount of dollars more than at present (position if he wins), and

C = the position of having 10 (25, 40) dollars less than at present (position if he loses the payment),

then equation (3) above becomes an inequality whose direction will depend upon the individual's choice in any one situation.

"Yes" implies $U(B) < pU(A) + (1 - p)\ U(C)$ and "No" implies $U(B) > pU(A) + (1 - p)\ U(C)$. Since "Yes" or "No" responses were the only ones admissable, and since it was postulated that a p exists which would make the individual indifferent, it was assumed that the point of indifference exists somewhere between any two situations of increasing gain (or loss) for the same odds for which the respondent's answer changed from "No" to "Yes."

Consider, for example, that a respondent had answered "No" to situation number 1 of table 1 for the *more-than-fair* odds, which means he would have been unwilling to pay \$10 to have a 1/20 chance of winning \$500, and "Yes" to number 2; this implies that his point of indifference for this particular set of odds occurs somewhere between \$500 and \$1,000. If we let B and $U(B) = 0$ (arbitrary origin), and $U(C) = \frac{-C}{5}$ (arbitrary unit of measure),[13] then the utility of the gain can be derived as follows:

$$U(A) = \left(\frac{1-p}{p}\right)\left(\frac{C}{5}\right) = 51.33$$

where p is postulated as the arithmetic average[14]

$$p = \frac{1}{2}\left(\frac{1}{20} + \frac{1}{40}\right) = \frac{3}{80}$$

and A as the average

$$A = \tfrac{1}{2}(\$500 + \$1{,}000) = \$750.$$

Further, suppose the respondent answered "No" to situation number 2 and "Yes" to number 3 for the *fair odds*, then similarly:

$$U(A) = 328.30$$

$$p = \frac{1}{2}\left(\frac{1}{40} + \frac{1}{200}\right) = \frac{3}{200}$$

$$A = \$3{,}000.$$

If we assume that for the *unfair odds* the respondent said "No" to situation number 3 and "Yes" to number 4, then the utility $U(A)$ for the point $A = \$7{,}500$ turns out to be 2,125.28.

[13] The 5 was chosen because 10, 25, and 40 are among its even divisors.

[14] If a large number of such cases are considered and the true indifference points are uniformly distributed over the interval, then the average indifference point can be represented by a point located halfway between the two situations.

The three points so determined can be plotted on a graph as shown in figure 1 or an equation can be fitted which represents the cardinal utility function for an individual with this particular set of indifference points.[15] A similar procedure was followed for deriving "disutility" functions from the answers to loss situations.

The equation fitted to these points was of the form $\hat{u} = ax + bx^2$, where $\hat{u}$ is the estimated utility and x is the amount of gain or loss. From

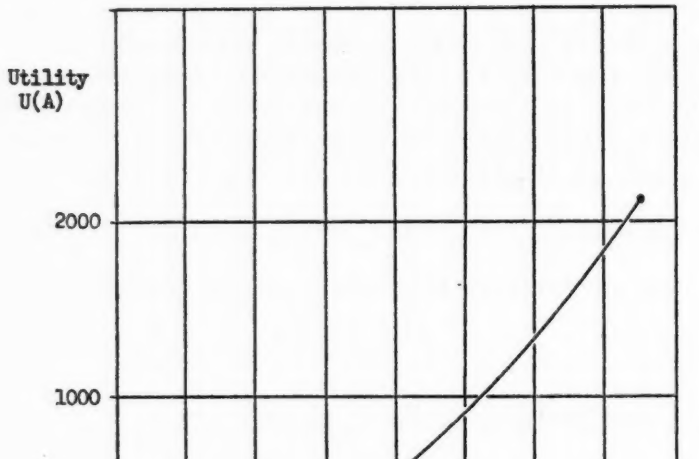

FIG. 1. EMPIRICALLY ESTIMATED UTILITY FUNCTION FOR A PERSON WHOSE INDIFFERENCE POINTS OCCURRED AT $750, $3,000 AND $7,500 FOR THE MF, F, AND UF ODDS SITUATIONS, RESPECTIVELY

this equation marginal utilities (disutilities) for gains (losses) were obtained for the following three points: (1) $3,000 gain and loss (approximate cost of a new car), (2) $7,500 gain and loss (approximate average annual gross income of respondents), and (3) $30,000 gain and loss (approximate value of a small farm).

The basic data underlying these empirically estimated utility functions were gathered in connection with the Interstate Managerial Survey in which 1,075 farm managers in North Dakota, Iowa, Kansas, Kentucky,

[15] The details of the entire analysis are given by Albert N. Halter, "Measuring Utility of Wealth Among Farm Managers" (Unpub. Ph.D. dis., Mich. State Univ., 1956).

Indiana, Ohio, and Michigan were interviewed to provide information relevant for a better understanding of the decision-making process.[16] Only about half of the farmers included in this survey were asked to answer the set of questions from which the utility functions were constructed. Out of these approximately 67 per cent gave answers which could be used for the purposes of utility function estimation. The others were inadequate for various reasons.[17] The various bets and insurance schemes listed in table 1 above were presented to these farm managers in the form illustrated below. By phrasing the questions in this way we had hoped to avoid the connotation of "roulette wheel gambling," an attempt which turned out to be not completely successful.

Example of the type of questions asked in obtaining farmers' responses to hypothetical gain and loss situations

Losses

If you were in a group of 1,500 people in which you knew one person would have to bear a loss of $10,000, would you be willing to pay $10 in order to get out of the group and thus avoid the risk of having to bear the loss?

Here is a group of similar situations. Please fill in your answer to show whether or not you would be willing to pay these costs to get out of groups in which one person has to bear a loss.

Number of people in group	1,000	Number of people in group	2,000
Amount of loss	$25,000	Amount of loss	$50,000
Cost of getting out of group	$ 25	Cost of getting out of group	$ 25
Yes____ No____		Yes____ No____	

Gains

If you knew that one person out of a group of 1,400 would get a piece of property worth $15,000, at no further cost to him, would you be willing to pay $15 out of your present income to become a member of that group?

Here is another group of situations that are similar to this one. Please fill in your answer to show whether or not you would be willing to pay these costs to get into a group in which one person would get the gain.

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[16] For details of this research project see papers by various authors in "Progress and Problems in Decision Making Studies," *J. Farm Econ.*, 37:1097-1125, Dec. 1955; also, Interstate Managerial Project Committee, *Summary Data from the Interstate Managerial Survey*, Ky. Agr. Exp. Sta. Bul. No. 669, 1958.

[17] For a detailed account of the reasons why some of these answers were insufficient, see Halter, *op. cit.*, pp. 42-62.

Number of people in group	40	Number of people in group	200
Value of property gained	$1,000	Value of property gained	$5,000
Amount you pay to get in	$ 25	Amount you pay to get in	$ 25
Yes____ No____		Yes____ No____	

III. *Interpretation of Managerial Behavior in Terms of the Estimated Utility Functions*

The Interstate Managerial Survey which provided the basic data underlying the empirically estimated utility functions also contained information about other important characteristics of the respondents. Among the characteristics investigated were age, schooling, farming experience, type of farming engaged in, farm income, total assets, debts, and similar attributes.[18] Several of these variables provided a basis for classifying the respondents into various groups which could then in turn be compared on the basis of the utility functions estimated for individuals within these groups. It should be recognized that correlations with characteristics do not necessarily constitute a thoroughgoing test of the expected utility hypothesis. Further, correlations cannot be substitutes for well formulated and tested empirical laws. However, at this stage of empirical work, the rough test as provided by chi-square comparisons suggests that the procedure used is a promising one and "whets the appetite" for future investigations. The following is a brief account of some of the important relationships which became apparent in this analysis:

Marginal Utility for Monetary Gains. Due to yield and price variability, it is generally considered that farmers specializing in either cash crops or fat-stock feeding are specializing in more risky undertakings than when engaged in other types of farming. Consequently, we were interested in determining whether or not a farm manager's marginal utility for monetary gains was related to his preference for risky enterprises. It can be seen from a study of the first five lines of table 2 that large proportions of farmers in those groups having relatively high marginal utility per dollar of wealth were also those who specialized in the more risky enterprises. Those farmers who were intermediate in marginal utility were combining fat stock and cash crops, or were in dairying or tobacco farming. Those who were lowest in respect to marginal utility per dollar of gain had a higher proportion in general farming than those with higher marginal utility. Further support is given to the relation between marginal utility and taking "risky" action by the fact that farmers with high marginal utility for monetary gains were also more likely to incur greater debts

[18] Space does not permit the inclusion of cross-tabular data for all the characteristics. This can be found in Halter, *op. cit.*, pp. 105-137.

TABLE 2. PROPORTION OF RESPONDENTS IN VARIOUS TYPES OF FARMING BY DERIVED MARGINAL UTILITY GROUPS FOR THE $30,000 GAIN AND LOSS SITUATIONS[a]

Marginal Utility (Disutility) Groups	Number	Type of Farming							Total
		Dairy	Fat Stock	Cash Crops	General	Fat Stock —Cash Crops	Tobacco	Other	
Gain Situations									
					Per cent				
.14 or .26[b]	61	9.8	36.1	27.9	9.8	8.2	3.3	4.9	100.0
0 – .30[c]	38	15.8	23.7	28.9	18.4	2.6	5.3	5.3	100.0
.31–1.00	62	24.2	17.8	35.5	1.6	9.7	6.5	4.8	100.0
1.56[d]	32	15.6	15.6	28.1	3.1	15.6	15.6	6.3	100.0
>1.00	34	5.9	32.4	41.2	11.8	5.9	2.9	0	100.0
Number	227	34	58	73	19	19	14	10	
Loss Situations									
0 – .40[c]	44	9.3	39.5	32.5	4.6	4.6	7.0	2.3	100.0
.41–1.00	69	10.4	26.9	44.8	3.0	4.5	7.5	3.0	100.0
1.01–2.00	60	26.6	26.6	26.6	9.4	6.3	3.1	1.6	100.0
1.56[d]	70	10.3	45.6	13.2	4.4	11.8	8.8	5.9	100.0
>2.00	58	10.5	19.3	36.8	12.3	12.3	1.8	7.0	100.0
Number	299	41	94	91	20	24	17	12	

[a] Chi-square significant at 10 per cent for gains and 1 per cent for losses.
[b] Marginal utility estimated for respondents who answered all "No" to fair (.14) or to unfair odds (.26); no utility function was fitted.
[c] The groups specified by an interval were defined by the derivative of the fitted utility function at $30,000 gain or loss.
[d] Marginal utility and disutility estimated for respondents who answered "Yes" to all odds (1.56); no utility function was fitted.

than persons with a low marginal utility per dollar of wealth.[19]

Marginal Disutility for Losses. Regarding the marginal disutility of losses which was derived in a way analogous to that used to derive the marginal utility of gains, it was found that the type of farming variable was again positively correlated with the measure. Farmers who showed a relatively large marginal disutility for losses of wealth engaged in relatively low-risk enterprises, namely general farming and a combination of fat-stock/cash-crop farming, while farmers who have a relatively smaller marginal disutility for losses were found in cash-crop farming similar to that prevalent in Iowa, Kansas, and North Dakota. The proportions in each type of farming category are shown in the lower half of table 2.

There was also some indication that farmers who have low net worths and low gross incomes also show a greater marginal disutility per dollar of loss than do farmers who have higher incomes and net worths. A possible explanation for this association is that, although engaged in enter-

[19] It was pointed out in section I, but should be re-emphasized here, that this statement does not imply any interpersonal comparisons of absolute value. The utility computation given in section II provides no estimates that are interpersonally comparable as would be provided by a measure which uses an absolute zero. However, it does provide an empirical concept from which predictions of actual interpersonally comparable behavior can be made.

TABLE 3. CONCERN FOR THE TWO TYPES OF ERRORS BY DERIVED TYPES FOR THE $30,000 LOSS SITUATIONS[a]

Marginal Disutility Groups[b]	Number	Proportion Concerned			Total
		First[c]	Second[d]	Both[e]	
		Per cent			
0– .40	43	27.9	27.9	44.2	100.0
.41– 1.00	65	16.9	38.5	44.6	100.0
1.01– 2.00	63	27.0	39.7	33.3	100.0
1.56	64	35.9	23.4	40.6	100.0
2.01–20.00+	56	28.6	39.3	32.1	100.0
Number	291	79	99	113	

[a] Chi-square significant at 30 per cent.
[b] See footnotes to table 1.
[c] More concerned about taking action when they should not.
[d] More concerned about not taking action when they should.
[e] Equally concerned about both types of error.

prises with a high probability of loss (or with a low probability of large monetary gain), individuals with a low marginal disutility for losses have participated in these situations and have been successful.

The questionnaire also included a question which asked the respondent to state whether he is more concerned about committing a Type 1 or a Type 2 error.[20] A comparison of the answers obtained with the estimates of marginal disutility revealed that individuals who have a high marginal disutility for losses, which is in part indicated by their willingness to participate in unfair insurance schemes, are also more concerned about not taking action when they should. This comparison is shown in table 3.

In addition to these specific conclusions, the following general observations resulted from the analysis:

Relatively older people with more years of farming experience, fewer dependents, relatively high net worths, and small amount of debts were less likely to answer that part of the questionnaire which contained the questions on gains and losses. The question on gains seemed to be much more difficult to handle for the respondents than the questions concerning monetary losses. The most plausible explanation is that most individuals are relatively familiar with insurance schemes when they think in terms of

[20] The respondent's concern for the two types of errors was indicated by his reply to the question: "In making farm decisions, are you more concerned about taking action when it would have been better not to than you are about not taking actions when you should have, or are you equally concerned about both of these?" For example, in deciding whether or not to buy a piece of land, a farmer can make either of two kinds of mistakes. He can buy land when he should not have. This mistake was made by many farmers after World War I. On the other hand, he can make the mistake of not buying land when he should have. This mistake was made by many farmers who did not buy land between 1935 and 1945.

matching the certainty of losing a small payment against their estimate of the likelihood of a large loss, whereas few businessmen and even fewer farmers think of their business ventures in terms of gambling against specified odds. This type of information is available in designing samples and questionnaires for future studies.[21]

For those individuals who gave consistent answers on both the gain and the loss questions it was found that the size of the gain necessary to induce acceptance of a risk situation with odds unfair to the individual was at least 26 times as large as the size of loss necessary to induce acceptance of an unfair insurance scheme.[22] It is this kind of prediction from the estimated utility functions that could furnish hypotheses of future studies. Having derived the utility function for an individual, it is possible to predict the size of gain or loss that he will attempt to get or avoid at specified odds. This prediction could be compared with actual behavior in situations where the actual odds are ascertainable. It is this kind of testing that still needs to be carried out before a great deal of reliance can be placed on our attempts at utility measurement. But, however crude this method and the results may be at the present time, it does open the possibility of bringing variables hitherto considered unmeasurable into the realm of quantitative determination.

Summary and Conclusions

The major purpose of this article was to suggest that the von Neumann-Morgenstern index for measuring cardinal utility may explain certain aspects of managerial behavior which are largely ignored by the traditional product-type and factor-cost oriented theory of the firm.

Section I presented our own interpretation of the meaning of cardinal utility measurement as developed by von Neumann and Morgenstern. It was pointed out that cardinal utility as measured by the index can be useful for our purposes, although it does not measure personal satisfaction and is therefore insufficient for purposes of welfare economics, which requires interpersonal comparisons of absolute marginal utilities. This fact does not rule out the usefulness of the index for purposes of making interpersonal comparisons of relative marginal utilities. It is this type of comparison which was employed in this study.

In Section II it was shown how hypothetical risk situations with which we confronted farm managers in a number of midwestern states could

[21] Further details can be found in Halter, *Ibid.*

[22] This conclusion indicated again that in order to get an estimate of the shape of the utility function on the gain side, it is necessary to include a much greater range of values than on the loss side, where a relatively small range of values proved to be sufficient. A similar conclusion was reached in a pilot study conducted by the authors in 1954.

be used to obtain empirical estimates of utility functions for individual farm managers.

In Section III the resulting utility estimates were analyzed in terms of certain managerial characteristics of the farm managers who were interviewed. The major conclusions reached were that farmers with relatively high marginal utility for monetary gains and correspondingly low marginal disutilities for monetary losses were found in high-risk types of farming operations. These people also showed a greater willingness to carry higher debt burdens than farmers with low relative marginal utility for gains and high disutility for losses.

On the basis of these results, it appears that the suggested method, although still very crude in its present form, may contribute significantly to the explanation of variables which have to date been largely ignored in economic analysis.

HOW THE MARKING OF BEEF GRADES WAS OBTAINED

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IT IS the thesis of this historical sketch that the marking of federal beef grades was conceived and born in controversy generated by conflicting economic interests. A review of the economic, political and human factors behind the first marking of federal grades of beef should dispel any notions about a neutral role of grades in our economy. To show the non-neutrality of grades is not synonymous with criticizing grades. The impact of grading is so intertwined with other institutional aspects of our market structure as to render economic analysis exceedingly difficult. Add the opposing viewpoints of various market participants and the sum is the present grading controversy. At best, this paper may help some students to understand better the origins of the controversy and some of its present economic aspects.

The Pioneer Promotion

Any record of the sires of grade marking must surely place Alvin H. Sanders, Editor of the *Breeder's Gazette*, at the head of the list. Sanders' long and fervent campaign in the columns of his paper and through individual contact with livestock leaders was undoubtedly the chief individual contribution to the marking of federal grades. Paradoxically, Sanders was not interested in grades in the beginning, and was more inclined to favor private than government grades.

Sanders' primary motivation appears many times in his editorials.[2] He wished to promote an increased demand for well-bred and well-fed beef which would increase the derived demand for purebred beef cattle.[3] Thus, he was able to relate his campaign very directly to the economic and sentimental interests of many of his readers and associates.

It is probably more than coincidental that Sanders' concern to increase the demand for better beef should develop in the agricultural recession of the early 1920's. Highly finished cattle were particularly penalized relative to other qualities in much of the 1924-26 period.[4] The derived demand for purebred animals was in the doldrums;[5] all sorts of "radical"

[1] Contribution from the Missouri Agricultural Experiment Station, Journal Series No. 2085. Approved by Director. Helpful criticism by Professors Elmer R. Kiehl, Jerry G. West, and Charles Cramer is gratefully acknowledged.

[2] Many *Breeder's Gazette* references beginning March 20, 1924, p. 378.

[3] *Breeder's Gazette*, June 25, 1925, p. 710; Nov. 4, 1925, p. 454, and Mar. 26, 1925, p. 338, are 3 of many examples.

[4] *Livestock and Meat Statistics*, USDA Stat. Bul. No. 230, pp. 213-16.

[5] *Breeder's Gazette*, May 18, 1922, p. 664; Mar. 26, 1925, p. 338; May 13, 1926, pp. 592-3. *Hereford Journal*, Aug. 15, 1926, pp. 2 and 4; Oct. 1, 1926 p. 2.

farm reform measures were being proposed by the Farm Bureau; and agreement was general that actions must be taken to restore agriculture's place in the sun. As a promoter and officer of the International Exposition and a life-long exponent of purebred quality, Sanders probably had several sentimental values threatened by the times. While Sanders apparently did not share the touching faith in the benefits of marketing reform shown by many, he could believe in a private campaign which would strengthen institutions and ideas which he had venerated for a lifetime.

Sanders' central argument rarely varied from the following: many consumers—the more well-to-do ones, especially—would buy better quality beef if they knew how to get it but many eating places and retailers do not carry better quality and/or palm off very poor quality meat instead. The argument varied over time in the color with which it was enunciated and the remedies suggested.

Sanders chose to dramatize the alleged inferior eating qualities of leaner beef with the terms "tiger-meat" or "cat-meat." "That splendid Siberian tiger at the other end of the row [in Lincoln Park Zoo] has fangs that would warrant his doing his shopping with any ordinary American retailer of beef. But what can comparatively weak human teeth and jaws do with the super-tough, red, lean stuff that is commonly vended in meat-shops? The fact that it is bought in such quantities, to the exclusion of the rich, tender corn-fed article, is the underlying trouble with cornbelt farming."[6] Sometimes, the "cat-meat" term was applied to dairy animals and scrub beef, but as the campaign accelerated the term came to mean almost all beef except that type now graded Prime. The "cat-meat" term caught the fancy of many interested in the matter and appeared many times in the *Breeder's Gazette* and in other livestock publications. It seems probable that this phase of his campaign did much to develop and solidify popular ideas as to the relationship between beef palatability and factors like breeding and degree of fatness. "That is the lesson the public needs to learn: the lesson that *lean* beef is necessarily poor beef."[7]

The remedy Sanders proposed was an educational campaign among the buyers for eating places and then among consumers. He was able to introduce several railroads to the marvels of buying prize show cattle at the International Exposition.[8] He publicized the "red ink menu" as a proper and fitting way to inform hotel and restaurant customers that the royal privilege of eating steaks from prime, show-cattle beef could be purchased.[9] He raked over the coals the New York Central Railroad when

[6] From editorial entitled " 'Cat Meat' and the Cornbelt," *Breeder's Gazette*, Mar. 12, 1925, p. 276.
[7] *Ibid.*, Sept. 17, 1925, p. 284. Italics in original.
[8] *Ibid.*, May 26, 1925, p. 622; Jan. 14, 1926, p. 40 and Jan. 28, 1926, pp. 16 and 105.
[9] *Ibid.*, Jan. 14, 1926, p. 40 and March 25, 1926, p. 366.

their red-ink menu appeared embellished with the photo of the head of a Jersey cow![10] Sanders enthusiastically supported meat exhibits and posters designed to show the difference in visual appearance between prime beef and tiger meat.[11] The National Live Stock and Meat Board was asked whether its new consumer radio program in California would teach the superiority of prime beef or "the same old continental European story of how to make a banquet out of a few bones and a dash of 'cat-meat'."[12]

By mid-1925, Editor Sanders began to suggest that the government might be able to work out some system of "tagging meat" for what it was. He reported that Dr. Mohler, Chief of the Bureau of Animal Industry, enthusiastically agreed with the tagging idea. Sanders suggested that letters of interested readers would be sympathetically received by Jardine, Secretary of Agriculture.[13] The purposes of the "tags" were to simplify buyer education and—much more important—to discourage the unscrupulous retailer from selling cheap beef as expensive beef.[14]

In November, 1925, the telling term "Better Beef" first appeared as applied to Sanders' campaign and the first contribution for a promotional organization was received from a Missouri County Agent.[15]

There was one other noteworthy promotional effort in this area prior to the organization of the first "Better Beef" committees in early 1926. A drive begun by O. M. Plummer of Oregon became known as the "truth-in-meats" campaign.[16] The truth-in-meats people had the same critical attitude toward consumer knowledge of and retail ethics concerning beef quality as did Sanders. However, as Western producers of medium to good quality beef, they were less than willing to designate their product as tiger meat. Rather, this group was concerned with differentiating their product from "scrub" beef and from dairy cattle. In particular, the droves of dairy cattle slaughtered in the TB eradication drives of the early '20's damaged their market and roused their ire.[17]

What were the roles of the USDA and the National Live Stock and Meat Board in promoting federal grading, "Better Beef" and "truth-in-meats?" While these agencies from the beginning were very cooperative, it appears doubtful that either provided noteworthy leadership in initiating the popular movements, although they made important contributions and added fuel to the flames.

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[10] *Ibid.*, Feb., 1928, p. 25.
[11] *Ibid.*, May 27, 1926, p. 658 and Jan. 7, 1926, p. 7.
[12] *Ibid.*, July 2, 1925, p. 6.
[13] *Ibid.*, April 9, 1925, p. 400; May 7, 1925, p. 514; May 14, 1925, p. 544.
[14] *Ibid.*, Sept. 24, 1925, p. 322.
[15] *Ibid.*, Nov. 12, 1925, p. 554.
[16] *Ibid.*, June 4, 1925, p. 633; *Hereford Journal*, June 1, 1926, pp. 10-11; *Breeder's Gazette*, Jan. 7, 1926, p. 13.
[17] *Hereford Journal*, June 1, 1926, pp. 10-11; *Ann. Rept. of Chief of Bur. of Animal Industry*, June 30, 1939, p. 65.

The Meat Board showed an early interest in grading as indicated by a resolution of general approval in June, 1925.[18] This resolution probably should be linked with the Board's support of Bureau of Agricultural Economics surveys of the retail meat trade in 1924 and 1925 and the resolution in 1924 calling for a study of factors affecting meat quality. No evidence was found to suggest who were the leaders in these Board actions nor what were their specific motivations. The Board's interests in retailing, meat quality, and grading appear to have been natural consequences of the Board's purposes, as stated in its first report: "education of the consumer in the true facts about meat and the conducting of new and important investigations into the nutritious value and marketing problems of the basic food."[19] While the results of the cooperative meat quality investigations were not available in time to affect the Better Beef movement, the findings of the Bureau of Agricultural Economics studies of retail trade and meat consumers were made available in early 1926 and were published as three bulletins later that year.[20] The 1926 Board Report noted highlights of the BAE conclusions and emphasized that "deception, substitution and misrepresentation in the sale of meat by a small percentage of dealers was found to be one of the major factors which is harmful to the industry in general, and legislation probably will be required to correct these practices."[21] Housewives were reported to emphasize the importance to them of meat palatability.

One, at least, of the conclusions appears to have overstrained the data a bit. It was claimed that great consumer ignorance was shown by the fact that 50 percent of the housewives said their retailers handled either the "best or very good quality" meat, which was obviously wrong—in the researcher's opinion—since only about nine percent of the nation's beef supply was of the top two grades which were the "best" and the "very good" quality meats. The 23 to 24 percent gross margins of an overcrowded and rather archaic retail industry also received attention.[22] The President of the American Hereford Journal Co. saw the truth-in-meats campaign as the solution of the "wicked waste" in retailing.[23] It was an unpleasant new era in American agriculture and nothing needed reforming as badly as middlemen.

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[18] *Ann. Rept. of Nat'l Live Stock & Meat Board*, 1926, pp. 76-77.

[19] *Ann. Rept. of Nat'l Live Stock & Meat Board*, June 30, 1924, p. 5.

[20] Kelsey B. Gardner, *Margins, Expenses and Profits in Retailing Meats*, USDA Dept. Bul. No. 1442, Nov. 1926; W. C. Davis, *Methods and Practices of Retailing Meat*, USDA Dept. Bul. No. 1441, Nov. 1926; Kelsey B. Gardner and L. A. Adams, *Consumer Habits and Preferences in the Purchase and Consumption of Meat*, USDA Dept. Bul. No. 1443, Nov. 1926.

[21] *Ann. Rept. of Nat'l Live Stock & Meat Board*, June 30, 1926, p. 71.

[22] *Ibid.*, pp. 69-75.

[23] *Hereford Journal*, July 15, 1926, p. 2.

Lloyd Tenny, C. V. Whalin, B. F. McCarthy and W. C. Davis of BAE were all enthusiasts for grades of farm products.[24] However, aside from a few articles published in cattlemen's and retailers' magazines[25] and a few grading demonstrations to large buyers[26] there is no evidence that these men played important leadership roles in the Better Beef movement.

Although the grading service was not in the Bureau of Animal Industry until 1939, the BAI Chief, Dr. John Mohler, was a minor participant in the Better Beef campaign. Editor Sanders quoted a letter from Mohler on June 11, 1925,[27] praising Sanders' editorials, and saying that his Bureau was preparing a poster for consumer education on beef quality. A full-page black and white reproduction of this large color poster later appeared containing a solid plug for marbling as the guide to tender and juicy beef.[28] Sanders quoted Mohler as observing that all forms of successful marketing eventually involve grading.

Both BAE and BAI contributed to the prevailing supreme confidence that adequate knowledge was already possessed to label beef for consumers as to eating quality. The fact that both agencies were cooperating with the Meat Board and many experiment stations in research designed to remedy admittedly great deficiencies in knowledge about beef quality and palatability apparently deterred no one. At this stage, researchers' confessions of ignorance would have been even less popular than usual with practical men of action.

"Consumers must learn the lesson that very lean beef is always tough beef, and that the muscular tissues of animals are made tender and fully flavored only by the presence of plenty of fat," W. C. Davis wrote in March, 1926.[29] "Neither sound teeth nor a keen appetite can make common beef taste like good or choice beef," wrote Mohler in July, 1925.[30]

Grades were definitely "producer-oriented" in the sense that the promoters were primarily concerned with *benefits for producers*.[31] However, as the foregoing statements of Sanders indicate, some of these promoters

[24] L. S. Tenny, "Standardization of Farm Products," *Annals Amer. Acad. of Pol. and Soc. Sci.*, May 1928, p. 205; W. C. Davis and C. V. Whalin, *Market Classes and Grades of Dressed Beef*, USDA Dept. Bul. No. 1246, 1924; C. B. Sherman, "The Consumer and Standardization in Food Products," *J. of Home Econ.*, Nov. 1928, pp. 801-803.

[25] *The Cattleman*, June 1925, pp. 31-32 and Mar. 1926, pp. 125-127; *Hereford Journal*, June 15, 1926, pp. 36-37; and *Butchers' Advocate*, May 26, 1926, pp. 10-12, June 16, 1926, pp. 9-10, June 22, 1927, pp. 9-10.

[26] *Ann. Rept. of Chief of Bur. of Agr. Econ.*, June 30, 1924, pp. 25-26.

[27] *Breeder's Gazette*, June 11, 1925, p. 662.

[28] *Ibid.*, Feb. 11, 1926, p. 171.

[29] *The Cattleman*, March 1926, p. 127.

[30] *Hereford Journal*, July 1, 1925, p. 6.

[31] "It is, of course, primarily the producer and only secondarily the consumer of prime beef in whom the *Gazette* is interested in connection with its fight on 'cat-meat'." Sanders' editorial, *Breeder's Gazette*, June 25, 1925, p. 710.

were aware that in order to derive benefits for producers, grades must have meaning in terms of consumer acceptability. There was a wishful extension of some results of experience and/or research into an overstrong case for the relationship of consumer acceptability to grades—by Sanders, especially. There was some injection of the gratuitous assumption that whatever costs more to produce must be better.[32] There was evidence of a smug superiority that consumer objection to fat beef was due to ignorance.[33] The point is that rather than a denial that grades must bear some relation to consumer wants, there was, instead, the ready rationalization that the existing grades-wants relationship actually was one which would also greatly benefit midwestern breeders and feeders. It is in these special and divergent senses that grades were both producer and consumer oriented. It should be added that packers indicated some honest doubts about this grade-quality thesis before grading became a hot issue.[34]

Organization of the Better Beef Association

Committees had been organized and "permanent" organizations founded to solve far smaller agricultural issues than the Better Beef issue had grown to be. Thus it was that John Clay, of the John Clay and Co. commission firm and President of the Chicago International Exposition, formed a committee representing the International which, at the call of Editor Sanders, who was also Vice President of the International, met in Chicago, April 27, 1926, with representatives of the three beef breed associations to consider the formation of a Better Beef Committee.[35] At that meeting a committee of five, consisting of B. H. Heide and W. W. Wright of the International, Frank W. Harding of the Shorthorn Breeders' Association, W. H. Tomhave of the Aberdeen-Angus Breeders' Association, and R. J. Kinzer of the Hereford Breeders' Association, was appointed to plan the organization of a permanent body to further the promotion of the Better Beef program.[36] Another committee of three headed by the greatly respected New York breeder and financier, Oakleigh Thorne, began an investigation of the "grading and distribution of prime beef in all leading domestic markets. . . ."[37]

Secretary Jardine, after meeting with Oakleigh Thorne, offered on June 3 to stamp beef grades free of charge to all packers operating under Federal supervision, beginning July 1, at request of packer.[38] Jardine's offer

[32] *Hereford Journal,* Sept. 1, 1926, pp. 38, 39; *Breeder's Gazette,* Feb. 24, 1927, pp. 198-199.

[33] Many references in Sanders' editorials.

[34] *Breeder's Gazette,* Mar. 20, 1924, p. 378 and Dec. 3, 1925, p. 667.

[35] *Ibid.,* Jan. 14, 1926, p. 40 and May 6, 1926, p. 563.

[36] *Ibid.,* May 6, 1926, p. 563; *Aberdeen Angus Journal,* May 10, 1926, has a front page picture of the participants, p. 1 and a story, p. 6.

[37] *Breeder's Gazette,* May 6, 1926, p. 563.

[38] The Secretary specified that "Prime No. A1" and "Choice No. 1" could be stamped

accelerated the anticipated pace of the organizational process and plans for a Better Beef Convention at Kansas City were quickly made.[39]

The Kansas City Better Beef Convention, July 22 and 23, 1926, was a somewhat typical agricultural meeting in one respect, at least. The cattlemen were outnumbered by representatives from the livestock markets, packing companies, railroads, agricultural organizations, colleges, USDA, the National Live Stock and Meat Board, the agricultural press, etc. The 200-member group heard the presentation of the points of view of many speakers, and elected a nine-member Board of Directors. These included Thorne, Sanders, Tomhave, Harding, Kinzer and also W. Blayney (a Denver packer), R. M. Kleberg (manager of King Ranch and president of the Texas and Southwestern Cattle Raisers' Association), A. C. Shallenberger (Nebraska Congressman and Shorthorn breeder), and W. J. Tod (Kansas cattle breeder and feeder).[40] Plans were made to incorporate in Illinois as the National Better Beef Committee. It was reported that one of the pioneer workers in the grading area, Louis D. Hall of Illinois, would be the executive secretary with headquarters in Chicago.[41]

Reconciling the Industry Conflicts

The individual competition of thousands of cattlemen with each other is normally of a very impersonal and even friendly nature, since the market action of a single individual has no discernible impact upon the welfare of the group. The horizontal competition among a few groups of cattlemen who are related as to the quality of cattle they produce and/or their production areas loses its large-group impersonality and tends to stimulate political conflicts. Likewise vertical competition between the producer of cattle and the meat packer and meat retailer is conducive to political conflict.[42]

Conflict between producer group interests began to be felt at the first committee meeting on April 27, 1926. R. J. Kinzer and John Painter of the Hereford Association insisted that the promotional campaign must be sup-

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even if no requests for stamping lower grades. *Breeder's Gazette,* June 10, 1926, pp. 701-02; *Hereford Journal,* Aug. 1, 1926, pp. 14-16; *Bur. of Agr. Econ. Service and Regulatory Announcement* No. 99, June 1926.

[39] *Breeder's Gazette,* June 3, 1926, p. 681, and June 10, 1926, p. 701.

[40] *Hereford Journal,* Aug. 1926, pp. 4, 6-9; *Kansas City Times,* July 23, 1926; *The Kansas City Star,* July 23, 1926; *The Weekly Kansas City Star,* July 28, 1926.

[41] *Hereford Journal,* Aug. 1, 1926, pp. 4-9; *National Wool Grower,* Sept. 1926, pp. 41-42; *Ann. Rept. of the Natl. Live Stock & Meat Board,* June 30, 1927, pp. 32-35; *Shorthorn World,* Aug. 10, 1926, p. 7. The absence of coverage of this meeting and the total movement by the general farm press is further evidence of the limited producer group involved.

[42] For interesting examples of economic and political conflicts among groups, see Joseph C. Palamountain, Jr., *The Politics of Distribution* (Cambridge: Harvard Univ. Press, 1955).

ported by a grading and stamping scheme to assure consumers that they were getting the quality being promoted.[43] The usefulness of grading as a promotional aid was fairly readily accepted, but the further plea of the Hereford representatives for grading all qualities of beef was not accepted.[44]

The conflict between the Midwestern breeder and the Western producer became more evident at Kansas City. The "Better Beef" group (Eastern and Midwestern breeders) desired an organization to promote the Prime and Choice grades which Secretary Jardine stood ready to stamp. The "truth-in-meats" group (Western cattlemen) demanded grading of all beef and a promotional campaign which did not discriminate against their beef. In short, each group viewed grading as a device for product differentiation and promotion. The Western group admitted that their cattle were not top quality beef (for lack of feeding, not of breeding) but they insisted that they be differentiated from "common" beef and dairy carcasses.[45] The *Aberdeen Angus Journal* sided with Sanders and editorialized that "beef is either prime or it is not prime."[46] Registered Angus cattle were very largely concentrated in the North Central region and in the East at this time, while Herefords were found more generally in the Southwest and West.[47] The *American Hereford Journal* became a spokesman of the Western group. Kleberg reported that on arrival at the Kansas City Convention he found that "this meeting had decided before it opened that the two top grades of beef should be graded, not considering the other."[48] However, the mark-all-grades sentiment apparently carried the day at Kansas City.[49] Oakleigh Thorne stated at the Des Moines meeting of directors on August 28, that no director at that time wished to limit grading to the top 2 or 3 grades. Thorne added, however, that the Board members did not favor marking cutter or below and that they thought that it might not be practicable to mark the lower grades until a demand developed.[50]

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[43] *Hereford Journal*, May 15, 1926. W. C. Davis of BAE was making essentially the same argument to retail groups at this time. *Butchers' Advocate*, May 26, 1926, pp. 10-12.

[44] *Hereford Journal*, May 15, 1926.

[45] *Ibid.*, Aug. 1, 1926, pp. 4-9 and 14-21; Sept. 1, 1926, pp. 22-23, 36, 38-39 and 45; April 15, 1927, p. 4; Feb. 1, 1927, pp. 44-45. Sanders' description of the meeting completely omits the controversy. *Breeder's Gazette*, July 29, 1926, p. 86.

[46] *Aberdeen-Angus Journal*, May 24, 1926, p. 6. Also see *ibid.*, June 21, 1926, pp. 6, 11.

[47] Henry W. Vaughan, *Breeds of Livestock in America* (Columbus: College Book Co., 1950), pp. 72 and 105.

[48] *The Cattleman*, April 1927, p. 21; Sept. 1926, p. 14.

[49] *Hereford Journal*, Aug. 1, 1926, pp. 4-9.

[50] *Ibid.*, Sept. 1, 1926, p. 36; *Aberdeen-Angus Journal*, Sept. 27, 1926, p. 6.

The Board of the Better Beef Association then performed a rather extraordinary about-face, drafting in November a bill for compulsory grading of all beef, and agreeing in December with packer representatives to the voluntary grading and marking of the top two grades.[51] Whether the November action was taken to satisfy the Western interests and/or intimidate the packers or indicated the genuine desires of the majority of the Board is not clear. The *Hereford Journal* editor argued that the December agreement showed the real interests of the majority of the Better Beef Association Board, and declared that the fight for compulsory grading of all beef must go on.[52] C. M. O'Donel, retiring president, and R. M. Kleberg at the next convention of the American National Live Stock Association after the December agreement both spoke in favor of compulsory grading of all beef.[53] In contrast, Sanders declared in November that "The *Gazette* does not subscribe to the proposition that the success of the Better Beef movement hinges entirely upon the installation of Government grading."[54] Sanders was understandably enthusiastic about the December agreement to label voluntarily the two top grades and called for a vigorous promotional effort.[55]

The conflict was actually three-sided. The packers were extremely cool to any kind of grading and, of course, found the compulsory grading bill more objectionable than the voluntary-two-top-grades proposition. A little grading was done for the Pennsylvania Railroad dining car department and for some other institutional and retail buyers after the July 1, 1926, offer of Jardine,[56] but it became obvious at the Kansas City Convention that the packers were dragging their feet. V. H. Munnecke, Armour vice-president, argued at Kansas City that all carcasses have to be sold, that the packer attempts to place every carcass where its particular degree of quality will bring the most money; therefore, beef is, in effect, graded already. Some people do not like those fat top grades, Munnecke

[51] For a draft and discussion of proposed bill, see *Hereford Journal*, Dec. 1, 1926, pp. 5, 24-25, and *Breeder's Gazette*, Oct. 28, 1926, p. 430. After negotiations from Dec. 6 to 16, a conference of representatives of packers and of the Better Beef Association obtained packer agreement for an experimental period of one year to quote on their price lists Prime and Choice government grades and to make available those two grades when requested by buyers. *Hereford Journal*, Feb. 1, 1927, pp. 44-45; *Breeder's Gazette*, Feb. 3, 1927, p. 109.

[52] *Hereford Journal*, Mar. 15, 1927, pp. 38-39.

[53] *Ibid.*, Mar. 1, 1927, p. 16.

[54] *Breeder's Gazette*, Nov. 4, 1926, p. 454.

[55] *Ibid.*, Feb. 3, 1927, p. 109.

[56] *Ibid.*, Oct. 7, 1926, p. 342; *Hereford Journal*, Dec. 1, 1926, pp. 24-25; The Van Gelder Market of Brooklyn, which began using government grades on September 14, 1926, was reportedly the first retailer in the U. S. to do so. By February 2, 1927, about 40 retailers in the New York City area were buying grade-stamped beef. *Butchers' Advocate*, Sept. 29, 1926, p. 9, and Feb. 2, 1929, p. 14.

added.[57] The packers' position at Kansas City was weakened by the particular state of the market. Painter complained that he had witnessed recently a load of Holstein TB reactor cows selling for $7.75 at Chicago on the same day that the best load of Hereford yearlings sold for only $9.25.[58]

The sparks of the producer-packer conflict were not noticeably fanned by any general anti-packer sentiment. The retailer was the culprit. Even though the National Association of Retail Meat Dealers supported grading, there was general agreement that there were many dealers engaged in quality misrepresentation.[59]

Nor was there an outright refusal of the packers to grade at the Kansas City meeting.[60] Perhaps the editor of the *Hereford Journal* was correct in claiming the packers were simply delaying until the whole affair faded away.[61] There was only one minor mention of grading (it cannot be done and would not help prices if it could) in the *National Provisioner* reports of the October 1926 convention of the Institute of American Meat Packers, which suggests that packers were not overly impressed with the magnitude of the Better Beef movement.[62] The compulsory grading bill of November aroused more packer attention and was attacked by Wentworth of Armour in a cleverly written article, which argued that the bill would not accomplish its admittedly commendable purposes. His objections were:

(1) beef grades cannot be uniform nationwide because choice quality for St. Louis or Los Angeles consumers is much less than choice for New Yorkers;
(2) the small proportion of consumers who will pay for high quality beef are doing so already;
(3) stigmatizing medium qualities with a mediocre grade tag will reduce their salability;
(4) there would still be confusing and irritating price variation within grades;
(5) the bill does not prevent retailer misrepresentation of quality;

[57] *Hereford Journal*, Aug. 1, 1926, pp. 4-9; See also *Breeder's Gazette*, Dec. 3, 1925, p. 667, for a letter from Armour president F. Edson White to Sanders, which cautioned that the consumer and not the producer is the judge of quality and that many consumers do not want large amounts of fat. Ironically, the first editorial of Sanders for better beef is in response to the criticism by Wentworth of Armour of the over-fat animals awarded show-ring championships. *Breeder's Gazette*, Mar. 20, 1924, p. 378.

[58] *Hereford Journal*, Aug. 1, 1926, pp. 4-9.

[59] *Breeder's Gazette*, June 24, 1926, pp. 746-747; *Butchers' Advocate*, June 16, 1926, pp. 9-10 and 14.

[60] *National Provisioner*, July 31, 1926, p. 31.

[61] *Hereford Journal*, Aug. 1, 1926, pp. 14-21.

[62] *National Provisioner*, Oct. 30, 1926, p. 117.

(6) the government would obtain more control of one of our most fundamental industries.[63]

None of these arguments was particularly persuasive to most of those within the Better Beef movement. However, the argument that grade marking would hurt the sale of lower grades was of first-rate concern to Western producers.

Quite obviously all three parties in this trianglar conflict saw through a glass darkly as to the economic consequences of this untried grades-marking scheme. Our present inability after three decades of experience to do much better should temper our appraisal of their arguments.

Early Days of Grade Branding

An essential feature of the December 1926 pact between the Better Beef Association and the packer representatives was that buyer requests for graded beef would be promoted through a special program in the National Live Stock and Meat Board. A. T. Edinger, on special leave from BAE, took vigorous charge of the promotion. Contacts were made with buyers for eating places and with retailers; thousands of explanatory bulletins and posters were distributed; radio talks were made to consumers, etc.[64] In the first year about 500 retailers in 200 cities signified a desire to feature the government stamp.[65]

Grade marking was begun on May 2, 1927, and its popularity grew slowly but steadily.[66] Only a very insignificant proportion of the total beef supply was graded the first few years, but the graded proportion of the top 2 grades was sizable.[67] The *Hereford Journal* editor felt that progress was painfully slow and doubted in April, 1929, if a single cut of government graded beef could be found in a Kansas City retail shop.[68] The considerably better prices for Prime and Choice cattle in 1927 was probably much more largely an effect of a 22 percent drop in receipts than

[63] *Shorthorn World*, Dec. 25, 1926, pp. 15-16.

[64] *Ann. Rept. of Natl. Live Stock & Meat Board*, June 30, 1927, pp. 32-36, and 46-49; *National Provisioner*, May 21, 1927, p. 52; *Butchers' Advocate*, May 4, 1927, pp. 10-11.

[65] *National Provisioner*, Sept. 1, 1928, pp. 23-26.

[66] *Aberdeen-Angus Journal*, Sept. 26, 1927, pp. 4-5; *Ann. Rept. of Natl. Live Stock & Meat Board*, June 30, 1927, pp. 32-36; June 30, 1928, pp. 17-21; June 30, 1929, pp. 44-46; June 30, 1930, pp. 74-77. This date is generally treated as the beginning, although some grading apparently was conducted previously, as already indicated.

[67] See Figure 1, p. 9, of Willard Williams, Earl K. Bowen, and Frank K. Genovese, *Economic Effects of U. S. Grades for Beef*, Marketing Res. Rept. No. 298, 1959; *National Provisioner*, Sept. 12, 1931, p. 32. By the last 6 months of 1935, some 24 percent of all Federally inspected Prime, Choice and Good grade steer and heifer carcasses were Federally graded, which amounted to 7 percent of all Federally inspected carcasses. *Ann. Rept. of Chief of Bur. of Agr. Econ.*, June 30, 1936, p. 14.

[68] *Hereford Journal*, April 1, 1929, pp. 16 and 17.

of any grade-stimulated increase in demand.[69] However, this price upturn helped Sanders and the Midwestern group to see the early days of grading in a much more favorable light than did the Western producers.[70]

The major packers paid government grading the high compliment of imitation, beginning with Swift three and one-half months after government branding got under way. Ingwersen of Swift credited the grading experience as a primary factor in their decision to private brand.[71] Sanders greeted the Swift announcement enthusiastically while Hazelton of the *Hereford Journal* characterized it as a monkey wrench thrown into the machinery of government grading.[72]

Packer grading caught on rapidly; all the Big Four packers were at it by the end of the year.[73] As of May 1, 1929, the equivalent of 148,675 carcasses had been branded privately as compared to 110,800 branded with government grades.[74] Packers began marking a third grade in June 1930, and Armour added a fourth grade in January 1932.[75] The volume of carcasses marked in the third packer grade in 1931 considerably exceeded the total number of first and second grade.[76] The Better Beef Association, the leading packers and the USDA agreed in early 1928 to mark "Good" grade.[77] Sanders viewed this change with foreboding and commented that Good is not literally good and that it "means only as much as the label No. 3 would mean."[78] It is hardly surprising that Hazelton approved the extension to Good grade and repeated his desire to obtain compulsory grading.[79]

The old charges that grading was unworkable had largely disappeared. Packing personnel displayed considerable enthusiasm for grades and brands.[80] However, large and small packers rather speedily developed differing preferences for private brands and federal grades, respectively.[81] Although large bargaining power had not yet developed on the buying side, the present-day attitudes of packers had begun to develop.

The Better Beef Association is last mentioned as a cooperating agency by the National Live Stock and Meat Board Report of June 1930.[82] Pre-

[69] *Shorthorn World*, Jan. 10, 1928, pp. 3-4.
[70] *Breeder's Gazette*, Sept. 1927, p. 20, and June, 1928, p. 28.
[71] *Ibid.*, Sept. 1927, p. 20.
[72] *Ibid.*, Sept. 1927, p. 20; *Hereford Journal*, Dec. 1, 1927, p. 18.
[73] *National Provisioner*, July 2, 1932, p. 23.
[74] *Ann. Rept. of Natl. Live Stock & Meat Board*, June 30, 1929, pp. 45-47.
[75] *Ibid.*, June 30, 1931, p. 107, and June 30, 1932, p. 82.
[76] *Ibid.*, June 30, 1932, p. 82.
[77] *Breeder's Gazette*, Feb. 1928, p. 25.
[78] *Ibid.*, Feb. 1930, p. 30. That "Good" is today's "Choice" grade.
[79] *Hereford Journal*, Feb. 1, 1928, p. 5.
[80] *National Provisioner*, July 2, 1932, p. 23.
[81] *Ibid.*, Sept. 12, 1931, p. 32; *Breeder's Gazette*, June, 1928, p. 28.
[82] *Ann. Rept. of Natl. Live Stock & Meat Board*, June 30, 1930, p. 11.

sumably, with its purposes largely accomplished and then with its founders awash in the far greater problems of the Great Depression, the Better Beef Association became no more. The Association's successes compare favorably with those of limited and special purpose farm organizations. Beef grades remain helpful to some economic interests and not to others, still relatively isolated from research findings, still rivaled by packer brands, but presently championed and used widely by a now-grown infant of the '20's, the chain stores with meat departments.

The Cooperative Meat Investigations of Beef Quality

The promoters outran the researchers. Research about the factors affecting meat palatability began in 1925 and bore its main fruits after the issues had been decided. The research answers were not only tardy but also complicated, untidy, and inconsistent in some measure with the desired and assumed answers. The promoters exercised excellent judgment in failing to wait for the researchers; they would not have been wholly satisfied.

By direction of a 1924 National Live Stock and Meat Board resolution, the general manager, R. C. Pollock, called a meeting of USDA and state animal husbandmen at Chicago, September 26-27, 1924, to organize cooperative research on factors affecting meat quality. After several months of investigation and negotiation by a committee of five, headed by Missouri's Dean F. B. Mumford, there was obtained agreement of 27 states to work together. The Directors of the State Agricultural Experiment Stations in April 1925 chose this project as one of a few to be financed under the new Purnell Act. Under the wings of the Association of Land Grant Colleges, the Meat Board and the American Society of Animal Production, these states, BAE, BAI, and the Bureau of Home Economics began the Cooperative Meat Investigations.

The personnel, the problems and, to a much lesser extent, the findings of the cooperative research are well documented in the annual reports of the Meat Board, 1925 to 1947.[83] The scope of the work as to number of participants, range of project interests, and length of time dwarfs many of our present regional projects. This is a story worthy of a telling, but only the barest summary of results pertaining to palatability, finish and breeding can be given here.

At the onset Mumford's investigating committee recognized not only the current lack of knowledge of the influence of various factors—feeding,

[83] Numerous reports were published by the cooperating agencies. Some of the major results are published in the Annual Reports of the Chiefs of the Bur. of Animal Ind. and the Bur. of Agr. Econ., and in five mimeographed volumes of abstracts issued by the Conf. on Cooperative Meat Investigations between 1937 and 1946.

breeding, age, sex, cooking, etc.—upon meat quality and palatability, but also the absence of definite standards and tools for measuring quality and palatability.[84] For example, the rather progressive meats laboratory at Missouri had virtually no refrigeration facilities nor many of the laboratory facilities now considered commonplace. So began the process of hacking out footholds, taking tumbles, and retracing steps, typical of pioneer research. While cattle and beef received primary attention, some work was done with other meats.

Gibbons of BAE in early 1929 was still willing to say, "official grade standards represent definite degrees of tenderness, juciness, fat, flavor, etc. With such standards in effect and generally understood the problem of the housewife and consumer will be reduced to one of deciding which grade is preferred under existing circumstances."[85] But the BAI report of 1929 noted that a comparison of 40 pairs of beef ribs from cattle of pure and scrub breeding and with slaughter grades varying from top good to top common showed no marked difference in palatability. "In fact, in several cases the rib roasts from the common calves were more tender than those of the grades and purebreds."[86] The 1930 BAI report noted that "the beef of mature steers fed on grass alone compared rather favorably in finish, tenderness, and palatability with that of similar steers receiving grass and a supplement of grain."[87]

The 1931 BAI report noted no difference in palatability among breeds but marked differences among carcasses within each breed, suggesting the need to identify and improve superior families or strains. Carcass grade had been found closely related to thickness of external fat which indicated the economic importance of determining the minimum degree of finish essential to "yield, attractiveness, storage quality, and consumer value."[88]

There were other results that Sanders must have found a little more palatable. Michigan data indicated "that with increasing fatness both the intensity and desirability of flavor of the lean and the quality or richness of juice of the roasted meat increase."[89] Several other experimenters found the fatter grades to be on the average a little more desirable than the leaner grades.[90]

In sum, the results of the Cooperative Meat Investigations failed to

[84] *Ann. Rept. of Natl. Live Stock & Meat Board,* 1925, pp. 57-64.
[85] *Advantages of Standards for Livestock and Meats,* USDA Misc. Bul. No. 33.
[86] *Ann. Rept. of Chief of Bur. of Animal Ind.,* 1929, pp. 7-8.
[87] *Ibid.,* 1930, p. 10.
[88] *Ibid.,* 1931, p. 9.
[89] *Ibid.,* 1934, p. 5.
[90] For example, L. H. Blakeslee and J. I. Miller, "Shear Tenderness Tests on Beef Short Loins," *J. of Animal Sci.,* 7:517; E. H. Hostetler, John Foster, and O. G. Hankins, *Production and Quality of Meat from Mature and Grade Yearling Cattle,* N. C. Bul. 307.

support adequately the grade-quality assumptions promoted by the Better Beef Association and used as a basis of federal grades. On the other hand, the researchers indicated no grading system or merchandising scheme which could reasonably be expected to be more profitable to the market interests concerned. It is hardly surprising that the system of grading and the accompanying ideology of the '20's should have survived relatively unscathed.

Historical Lessons

There is rarely universal agreement as to the implications for our time of a record of past events. However, four specific "lessons" seem to this writer to be worthy of emphasis.

1. The retail *marking* of grades was an entirely separate issue from the use of live and wholesale grades for price reporting. BAE grades were in use for price reporting almost a decade before a campaign was begun to mark grades.[91]

Grade marking was motivated by a desire to reduce the degree of control of consumer demand by the retailer, and, in effect, "educate" the consumer to demand the beef qualities which the Better Beef Association was promoting. "Stop retailer misrepresentation" was the battle cry. Packers appear to have been largely content with the existing market structure, as they had considerable market power vis-à-vis the typical meat market. Their subsequent private branding has appearance of a countermeasure. If market demand for qualities was going to be transferred more largely into consumer hands, via grades, then the differentiation by packers of services, etc. developed to attract a retailer following must be broadened to include a product differentiation with attraction for the consumer.

There is no evidence that grades were an effective lever for bringing retailers "in line" during the life-time of the Better Beef Association. A careful study of the accuracy with which modern retailers transmit the preferences of consumers to processors would seem worthwhile in connection with the economic appraisal of any grading system. However, it appears doubtful that an accurate appraisal can presently be made of the retailing of beef. Other research indicates that beef grades and brands have been so heterogeneous in eating quality as to hamper greatly any comparison of grades and preferences.[92] However, the advent of large-scale retailing and the current retail emphasis upon quality repeatability probably render somewhat superfluous the need for retail grade marking as a deterrent to "quality misrepresentation." It is a bit ironic that a large

[91] Dowell, Austin and Bjorka, Knute, *Livestock Marketing* (New York: McGraw-Hill, 1941), pp. 288-293.

[92] Mo. Res. Bul. 612, 651, 652, 676, 677; Ariz. Rept. No. 145; and Texas Exp. Sta. Bul. 889.

producer organization's recent request for the termination of lamb grade marking was strongly opposed by several organizations of packers, retailers and institutional users.[93]

It might clarify the thinking of various participants in the present grading controversy to separate the price-reporting function of grades from the affecting-consumer-demand-via-retail-marks function and to ask themselves if they have the same attitudes toward each function.

2. The anticipated impact of grades upon market participants was non-neutral. The consequence was a three-way political struggle among two producer groups and the meat packers. While the economic interests of certain retailers were also involved, those supposedly "guilty of misrepresentation" of beef quality had no representation in the national organization of retailers and no political influence.

Those market participants who profit by a lack of information in the marketplace can be expected to oppose the price reporting function of grades. Most economists will probably have little difficulty in drawing welfare conclusions even though someone is made "worse off" by the use of grades to aid price reporting.

The conflict among producer groups and meat packers over the use of grades to promote a certain type of beef—and, indirectly, purebred beef cattle—was of a somewhat different nature. Those producers who did not produce the top grade had a legitimate concern that the merchandising of their output not be hindered by retail grade marking. Such producers would have had even more cause for complaint if they had possessed evidence that the eating quality of much of their beef was equivalent to that given the "top" grade.

It appears to be time for a renewed realization that use of retail grade marking as a promotional device is likely to discriminate against certain areas and types of production. Once this particular welfare problem is faced, perhaps economists will be quick to give their value judgments. In any case, the typical textbook ignoring of this welfare problem needs to be ended.

3. The early impact of grading upon market structure and performance was swallowed up by the onslaught of the Great Depression, by the changes in size and bargaining power of various participants and by changing merchandising methods. It appears possible that the present impact of grades as a promotional device is being exaggerated by many participants in the present controversy.

4. The marking of grades was developed by producers for the benefit of producers. The political power of packers was insufficient to more than

[93] *National Provisioner*, April 25, 1959, May 2, 1959, and May 9, 1959.

slightly modify. Consumers had neither understanding nor political representation. The only reason that consumer preferences were discussed was the confidence that they were consistent with the desire to promote well-fed, purebred beef. Many large retailers and institutional buyers now find grades useful in procurement and/or merchandising. Consequently, the present political forces concerning grading have drastically altered since the beginning of grade marking. This alteration has reduced the political control over grades by producer and packer. Of course, a shift in political power need not be accompanied by a shift in economic benefits.

5. Although the degree of usefulness of grades as a promotional device was directly related to the degree of association between grades and consumer palatability, there was little research information available about that association.[94]

Presumably only the very naive will be shocked at learning that an official standard was based upon entirely inadequate research. Certainly, the relevant question for appraising today's grading system is this one: Is it better than no system or than any available alternative system? Readers interested in that question are referred to an extensive set of publications issued recently by the Missouri Station and by other researchers.[95] It should be hastily added that no completely satisfactory answer is yet at hand. Research cannot solve valuation conflicts, of course. However, it can be hoped that research discoveries that certain goals are non-existent or greatly different than visualized by market participants would place the valuation conflicts on a more reasonable and fruitful basis. Charging windmills may be great sport but the efficiency experts frown upon it.

The historical finding of inadequate and somewhat inconclusive research on the relationship of grades and palatability should not prejudice our appraisal of present grade standards. However, this finding should aid the understanding of many economists and other researchers presently disturbed by assumed conflicts between present consumer preference research and past research. In the main, results of past research—inadequate as it was—were of the same general nature as present research. The main conflict is not between research of two eras but rather between research and the promotional ideology of the Better Beef movement.

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[94] The BAE grades were largely based upon the early research of Hall and Mumford, which systematized current trade terminology and made no investigation of palatability relationships.

[95] See footnote 92.

NOTES

THE ECONOMICS OF GROUND WATER ALLOCATION: A CASE STUDY[1,2]

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Introduction

PROBLEMS of water allocation have taken on added importance in recent years. These problems are complicated by difficult physical relationships and institutional considerations which are reflected to a large extent in the legal framework governing water allocation. The purpose of this paper is to: (1) illustrate an application of economics within a particular ground water doctrine; (2) illustrate an empirical method of relating relevant variables in a water allocation problem; and (3) discuss implications of the study to the design, development, and modification of the institutional framework within which water is allocated.

The Milton-Freewater ground water basin in Oregon was selected for intensive study in consultation with the State Engineer's Office. This area was selected as an example of a situation where water is likely to become limiting. The probable effects of different allocations of water were then studied relative to a specific physical and legal setting.

Two rather distinct types of farming areas have developed, because of the physical characteristics of the basin. Part of the basin is devoted to fruit growing (referred to hereafter as Area I). The soils are predominantly of the Yakima series. Because of their rocky nature, these soils are not well suited to the production of a large number of commodities. Principal fruits grown are prunes, apples, and cherries. The other type of farming is centered chiefly in the Ritzville soil series (referred to hereafter as Area II). This soil is a deep, highly productive loam ranging from sandy loam to loam with considerable clay content. The type of farming in this area centers around the production of sugar beets, alfalfa hay and small grains.

[1] This article is based on research accomplished on Oregon's contribution to regional project W-42, entitled *Economic Analysis of Laws and Related Institutions Affecting Ground Water Use in the Western States.* The article draws heavily on the following studies: "Economic Effects of Different Allocations of Ground Water Within Agriculture in the Milton-Freewater Area of Oregon," Karl H. Lindeborg, unpublished Ph.D. thesis, Oregon State College, December 1958; and "Economic Implications of the Oregon Ground Water Laws," Harvey K. Warrick, unpublished M.S. thesis, Oregon State College, June 1957. Helpful suggestions were received from G. E. Korzan, Grant E. Blanch, S. V. Ciriacy-Wantrup, Frank Trelease, G. B. Wood, and W. G. Brown as well as from W-42 committee members.

[2] Technical Paper 1282, Oregon Agricultural Experiment Station.

Area I was settled first and water was first developed in this area. Both areas could expand profitably their use of water. Many farmers are drilling wells or are considering the drilling of wells to supplement or replace their surface water sources. Irrigation is the big user of water in the basin. This is likely to be the case in the future. Other uses are municipal and industrial, with industrial water being used mostly for food processing.

In Oregon, the doctrine of prior appropriation applies to the ground water of the state.[3] Beneficial use without waste is the basis, measure and extent of the right to appropriate ground water. Preference is given to domestic and livestock purposes. Other uses such as agricultural, industrial, municipal other than domestic, and recreational are recognized as beneficial but no priority is assigned, leaving the determination in specific cases to administrative agencies.[4]

Rather broad powers have been given to administrative groups. In 1955, a State Water Resources Board was created with broad policy powers over the unappropriated water of the state. The State Engineer's Office, on the other hand, is viewed more as an action agency. The Engineer's major responsibility is to carry out the policy of the legislature and the State Water Resources Board. Yet the Ground Water Law, which was also passed by the 1955 legislature, gives the Engineer considerable leeway in certain matters. Of relevance here is his authority to institute a number of control measures in the event he believes a ground water area should be designated as critical.

The Analytical Framework

In theory it is possible to define a social optimum in the use of water. This involves a surface which would define the "product" forthcoming from all possible allocations of water among all possible uses. The "product" would need to be valued by means of a utility function. But this "utopian" model is not operational for the practical problem at hand. Numerous modifications must be made in order to establish a useful economic framework.

The case study problem involves the allocation of water between Area I and Area II. Ideally, one would need to know the individual production functions for water in each area. However, all that a study of water use in the areas will reveal is one point on each production function. This point will reflect the combination of water, land and other inputs that farmers have arrived at in practice. This combination reflects the cost of

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[3] Oregon laws, Chapter 708.

[4] In the case of ground water shortage, the State Engineer has the power to decide priority among such uses. Provision is made, however, for appeal to the State Water Resources Board. Eventually, of course, the matter could be carried to the courts. This point is discussed in more detail later.

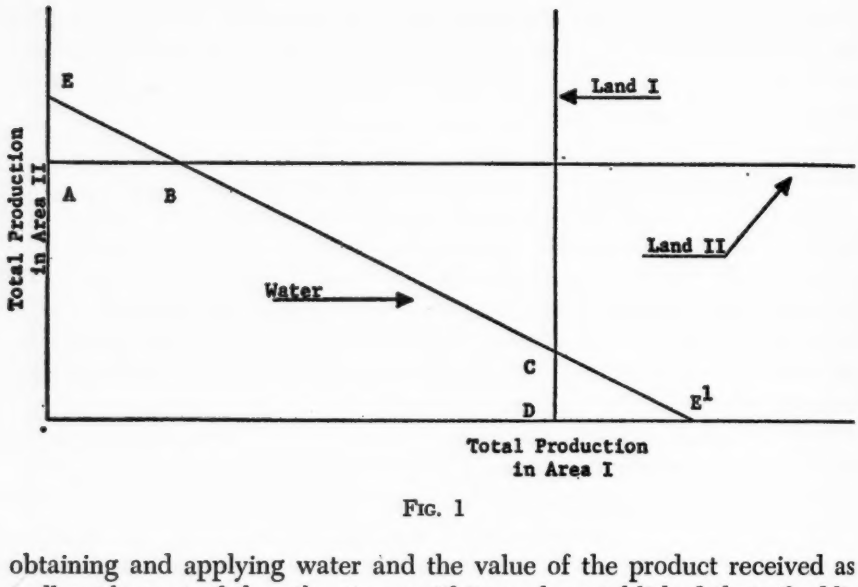

FIG. 1

obtaining and applying water and the value of the product received as well as the cost of the other inputs. If it can be established that, if additional water were made available in the areas, farmers would expand their use of other inputs in proportion to the increase in water, the problem is more easily managed. This would mean that if it requires 3 acre feet of water to irrigate prunes and if an additional 300 acre feet are made available, an additional 100 acres of prunes will be irrigated. The result of this would be that a water transformation curve between the areas would be of the nature of EE^1 in Figure 1.

There is, of course, no way of establishing the exact nature of this function short of a controlled experiment. However, the hypothesis that the transformation function is linear between the areas appears to be consistent with farmer decisions and practices in the area. In effect, this assumes that farmers will organize their inputs in the future in approximately the same way as at present. If it is accepted that the determinants of the way in which these inputs are organized are the prices of the products produced and the cost and productivity of the inputs, the assumption appears reasonable for the problem at hand. These items are not within the control of an administrative water agency, nor are they likely to be. The linear transformation function would not hold for other areas with which the authors are familiar but appears to be the most reasonable assumption for the case study area.

Market prices and costs were used as choice indicators. This involves a value judgment in that it accepts consumer sovereignty. Yet any administrator must accept certain conditions as given. If he objects to the distri-

bution of income, or to the market structure within the economy, or even to the ways consumers spend their money, he should recognize that these are separate problems that cannot be attacked successfully within the framework of the water allocation problem.

A simplified version of the model used is presented in Figure 1. The natural resources of the basin are limiting factors; that is, the land area and the water. The available land in each area together with the water substitution curve defines the relevant transformation function, ABCD.

Since natural resources were assumed to be limiting, linear programming was used to maximize net returns to these resources. The "optimum" allocation is apparent from inspection of the data. Programming was used because of its potential usefulness for more complex problems and because of the values that it places on the limiting resources. These values have usefulness in water allocation decision making within institutional restrictions. This point will be developed later.

Empirical Analysis

The following steps were necessary to estimate numerical values for the variables outlined in the previous section:

1. Estimate costs and returns for various enterprises in each area.
2. Determine the acreage of each enterprise that would exist in each area assuming "irrigation" and "nonirrigation."
3. Determine the "acre profitability" of the composite enterprise for each area. This involved subtracting all costs of production except land costs from the likely sales value of the composite enterprise.
4. Determine the "optimum" allocation of water on the basis of existing land and water resources and the enterprise costs and returns.
5. Check the stability of this solution against historical changes in price relationships.

In order to acquire the necessary data, a survey was made in each area. There were 288 farms in Area I and 216 in Area II. In Area I, 47 farms were surveyed, and 45 farms were surveyed in Area II. The data were collected in the summer of 1957. Information was obtained about the farm organization, production practices, water usage, number and depth of wells, pumping lift and pumping capacity. Table 1 summarizes some of the relevant information.

In arriving at a solution to the allocation problem, linear programming was used. The limiting factors are listed below:

Item	*Quantity Available*
Land I	10,240 acres
Land II	24,365 acres
Water	69,200 acre feet

TABLE 1. COMPARISON OF CROP YIELDS AND COMPOSITE ACRE PROFITABILITY, AREAS I AND II, WITH AND WITHOUT IRRIGATION

Enterprise	Yield per Acre	Price[2]	Composite Profitability[3]
Area I—Irrigated[1]			
Apples	248.36 bu.	$ 2.68	$109.02
Prunes	8.19 ton	65.82	64.44
Cherries	3.57 ton	242.20	33.76
Tomatoes	394.50 bu.	3.05	54.93
Asparagus	1.75 ton	198.20	.88
Total profit per composite acre			$263.03
Area I—Nonirrigated			
Apples	125.00 bu.	$ 2.68	$ 31.95
Prunes	4.00 ton	65.82	5.59
Cherries	1.75 ton	242.20	8.14
Small grain	1.36 ton	20.00	0.24
Alfalfa	1.33 ton	20.00	0.98
Total profit per composite acre			$ 46.90
Area II—Irrigated[4]			
Wheat	44.00 bu.	$ 2.00	$ 7.24
Oats	60.00 bu.	0.81	0.17
Barley	40.00 bu.	1.19	0.19
Sugar beets	20.00 ton	11.14	8.08
Green peas	1.20 ton	85.40	1.51
Lima beans	0.75 ton	170.00	0.10
Alfalfa	4.70 ton	20.00	19.62
Pasture	1.93 ton	20.00	.90
Total profit per composite acre			$ 37.81
Area II—Nonirrigated			
Wheat	25.00 bu.	$ 2.00	$ 6.75
Oats	32.00 bu.	.81	0.06
Barley	35.00 bu.	1.19	0.29
Alfalfa	1.33 ton	20.00	0.51
Pasture	1.133 ton	20.00	6.97
Total profit per composite acre			$ 14.58

[1] 3.16 acre feet per acre.
[2] 1951–56 average.
[3] Individual crops are weighted according to existing land use under irrigated and nonirrigated conditions in each area, so that the totals represent composite profit per acre, at 1951–56 average prices of inputs and products, for the area and condition specified, with existing cropping patterns.
[4] 2.92 acre feet per acre.

Available water was estimated on the basis of geologic information. Per ton requirements were obtained by dividing acre requirements by yield per acre.

The solution involved irrigating all of Area I, and exhausting the remaining amount of water on Area II. The water was insufficient to irri-

gate all of Area II; therefore, nonirrigated crops had to be grown on the remainder of Area II.

The programming solution also allocates the returns to the fixed factors; among those factors the returns were as follows:[5]

Land I	$237.85 per acre
Land II	14.58 per acre
Water	7.97 per acre foot

If a model such as this is to be considered seriously for policy purposes, the solution obtained would need to exhibit certain stability characteristics. To obtain some notion of the possible stability of the model, Table 2 was prepared.

TABLE 2. LIMITS WITHIN WHICH PROGRAM WOULD REMAIN OPTIMUM EXPRESSED ON AN INDEX BASIS

Enterprise	Value Used In Solution	Lower Limit	Upper Limit
Irrigated crops Land I	100	27	—[1]
Non-irrigated crops Land I	100	—[2]	507
Irrigated crops Land II	100	89	566
Non-irrigated crops Land II	100	0	260

[1] This enterprise is in the solution to the limit of the land available. Further increases in net revenue would not affect the solution.

[2] This enterprise is not in the solution and only an increase in net revenue can affect the solution.

Although historical prices of some commodities were not available, in no year of record would the optimum solution have been changed. It is probable that future price relationships will tend to favor fruits relative to vegetables. Under such circumstances, this particular allocation will tend to be more "firm." Various assumptions could be made as to future price relationships that would further test the stability of the allocation. Although the basic model was static, it is believed such a procedure can give insights into its future applicability. It is possible, of course, that fruit might shift to Area II. However, Area II is not as well protected from weather hazards as Area I and yields probably would not be as favorable.

Programs were worked with various assumptions as to the quantities of water available for allocation as follows: (1) that sufficient water was available to irrigate only part of Area I, (2) that sufficient water was avail-

[5] The above values are not discounted in any way for risk and uncertainty. They appear too high if capitalized and compared with the sale value of land in the area. The relative values appear reasonable, however.

able to irrigate Area I and part of Area II (actual situation), and (3) that sufficient water was available to irrigate both areas. The following values were obtained:

Assumption	*Value of an Acre Foot of Water*
1	$68.37
2	7.97
3	0

The "marginal" values obtained by programming are not identical to the marginal value products of traditional theory. Programming assumes that all inputs will vary proportionally until one input is exhausted. The "marginal" values obtained, therefore, are in reality average values over that range. By changing assumptions as to the quantity of an input available a series of these average or "marginal" values can be obtained. It is believed these values would be of interest to a water administrator. For example, if a non-agricultural water use were to be considered, these values would represent an opportunity cost for that use.

Legal and Institutional Implications

In this section, conclusions will be drawn with respect to possible applications within the institutional framework for water allocation. A careful reading of ground-water law indicates that economic considerations are intended to be given weight. Beneficial use is the important concept under the doctrine of prior appropriation. Presumably, in the event of conflict among uses and users, this concept would be crucial in decision making. A clear understanding of this concept as interpreted in the law should provide a basis for determining the extent to which economic criteria are or can be used in defining beneficial use in specific cases. Two articles by attorneys will be relied upon heavily to indicate the legal meaning of the term.[6]

It may appear to one making a review of court cases in which the concept was used that the legal definition is largely devoid of economics. A use is often defined independent of another use. Such singular consideration of uses does not appear to provide expression of the principle of opportunity cost which appears to be the relevant economic concept. Yet

[6] These articles were contributed specifically to meet this need for understanding on the part of economists. The articles are:

"The Concept of Reasonable Beneficial Use in the Law of Surface Streams," by Frank J. Trelease.

"The Concept of Reasonable Beneficial Use in the Development of Ground Water Law in the West," by Wells A. Hutchins.

These articles appear in "Ground Water Economics and the Law," Report 5, Conf. Proc. of the Comm. on the Economics of Water Resources Development and Western Regional Research Comm. W-42, at Berkeley, Calif., December 20 and 21, 1956.

court cases involve conflicts between uses. In effect the arguments pertain to which use was the *more* beneficial (though this is often not the explicit form of the argument).

In one case the judge reasoned precisely according to the principle of opportunity cost. The case involved the use of water on the Deschutes River in Oregon where the use of water to clean debris from a reservoir to prevent the fouling of electric turbines was denied. The court recognized that the use of water for this purpose would prevent the irrigation of 1,600 acres of land, and held that the use of water for cleaning the reservoir was wasteful, stating that the difference between absolute and economic waste was one of degree only.[7] On the other hand, courts have been somewhat slow to exercise leadership in this respect. They have relied upon the legislature to state preference classes. They have also held close to the constitutional policy of protecting property rights. Hutchins makes the following statement:

> Once an appropriative right has been vested, its superior position with respect to later rights is impregnable so long as the right is kept in good standing. That is to say, despite constitutional and legislative declarations that in times of scarcity one use shall be preferred over others, no court decision that has come to the speaker's attention has sanctioned the imposition of such a preference, in disregard of priority of appropriation, without making compensation to the senior appropriator whose water is taken for the preferred use.[8]

Yet the payment of compensation does not violate the principles of efficiency of resource use, unless the gain from diverting to the second use is insufficient for the payment of compensation.

Given the legal and physical setting of the case study area, an administrator might be faced with either of two situations: (1) What course of action should he take if an application is made for unappropriated waters? (2) How should he allocate a limited water supply when the ground water level is falling?

In case of application for unappropriated waters a permit may be refused if, in the judgment of the State Water Resources Board, it does not represent the best use of the water of the state. In this connection, should an applicant wish to use water in Area II, the results of this study might be used as a basis for deciding on his application. The appropriate administrative agency would be faced with the following problem. Should they deny the use of water in Area II, it might be some time before an applicant from Area I would wish to use the water. An opportunity cost would be suffered by society involving the non-use of water during the intervening period, but the potential user in Area II will be unwilling to develop

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[7] Trelease, Frank J., *op. cit.*, p. 16.
[8] Hutchins, Wells A., *op. cit.*, p. 32.

the water unless he has security in his water right. If a water right is granted in Area II and this precludes development in Area I, water obviously is not being put to its most economic use. The results of the analysis help to clarify this problem somewhat. The annual economic return to one acre foot of water in Area II is $7.97. In Area I it is $68.37. If the economic return in Area II is treated as an annuity and accumulated at 5 percent, and the annual return in Area I is discounted at the same rate of interest, the two become equal during the seventh year. If it is believed an application would be forthcoming within seven years in Area I, the water right in Area II should not be granted. With this much differential, the application probably would be forthcoming before seven years had elapsed. There may be instances, however, when future developments can be foreseen and reservation of water would be good policy.

It might also be possible to grant a water right with the reservation that it could be withdrawn after a certain number of years had elapsed. However, this brings up involved legal and welfare problems. If a water right is to be transferred, wealth is obviously being redistributed. It probably would be more consistent with ground water doctrine and our ideas of equity to bring about transfer by the payment of compensation. This point is discussed below.

In the event of water shortage or a falling ground water table, stress is placed on a system of ground water rights. Under such circumstances the results of a study, such as the one reported on here, could be of value. The application of these results would be under the provision of the law that reads as follows:

> A provision according preference without reference to relative priorities to withdrawals of ground water in the critical area for domestic and livestock purposes first, and thereafter, other beneficial purposes, including agricultural, industrial, municipal other than domestic, and recreational purposes in such order as the State Engineer deems advisable under the circumstances.[9]

Although this does not specify that users within a use class might be treated differently, it is believed this provision is sufficiently broad to cover such a contingency. If the information were avaliable it would be possible to choose among uses on the same basis.

Finally, a word about compensation. A transfer of income would result if a water right were discontinued in Area II and the water was used in Area I unless compensation was paid. The value of an acre foot of water in Area II capitalized at five percent would amount to $159.40. The money needed to pay the compensation might be raised by selling water

[9] Oregon Laws, Chapter 700, p. 12. A competent legal scholar has indicated this provision may be unconstitutional. He also doubts the wisdom of the provision. This is a legal problem and the analysis would not apply if the provision is not applicable.

rights to appropriators in Area I. If the figures developed are accurate, an appropriator in Area I would be willing to pay $68.37 annually for an acre foot of water. At this rate it would take the Area I appropriator 2⅓ years to recover his original investment.

Welfare economics would indicate that if national riches are to be increased, sufficient gain should result from the transfer to permit compensation to be paid. If the criterion is adopted of making no one "worse off" compensation should, of course, actually be paid. Property rights are usually protected in the law by the compensation provision.

If a market for water rights existed it would be possible for a developer in Area I to buy rights directly from irrigators in Area II. If this could be done, the results would be the same as those outlined above. However, in a ground water basin, water is not sufficiently well identified to permit this. In most cases, it would be necessary to have an administrative agency regulate the location of wells as well as to select the rights to be withdrawn. There are other limitations to a market system of transferring water rights but these are outside the limitations of this paper. This is an area of possible fruitful research.

Conclusions

It appears that the doctrine of prior appropriation is capable of being modified and interpreted so that serious malallocations of water need not result. If transfer of water rights is made possible by administrative procedure, either directly or by approval, there appears to be no reason why water cannot be allocated to its most economic use or user. At the same time sufficient protection is provided to encourage development. In the case of ground water it would appear that a regulatory agency would need to supervise the transfer of water rights. With surface water a relatively free market system may be adequate.

If administrative agencies supervise the transfer of water rights it is apparent they must have access to considerable information on the economic magnitudes involved. This calls for rather precise determinations of the effect of possible allocations. If economists, for one reason or another, cannot supply such information, their contribution will be in the nature of guiding policy in a particular direction rather than in giving specific advice on particular allocations. But it does not minimize the importance of such guidance to hope for and work toward the more specific contribution.[10]

In this connection much uncertainty exists as to the value of quantitative techniques in water allocation. Although this paper has dealt with a

[10] See the excellent article by S. V. Ciriacy-Wantrup, "Concepts Used as Economic Criteria for a System of Water Rights," *Land Econ.*, Vol. XXXII, No. 4, Nov. 1956.

relatively simple problem, it is believed the technique could be applied to more complex situations. For example, "uses" could be considered in addition to "users." The assumptions of competition between uses or users would need to be examined in view of the facts of the case. The method permits taking account of complementary or supplementary relationships as well as competitive, if these relationships are known.

This study neither exhausts the possibilities of linear programming nor does it illustrate all of its limitations.[11] For the case study reported on here, the method was of value only in problem formulation. However, when the number of variables becomes large some such technique must be used if quantitative answers on allocations are to be obtained. But much remains to be done before the method can be used widely. Underlying physical relationships must be specified; the institutional framework must be studied and incorporated; and water quality and dynamics must be introduced if reality is to be approached.

[11] For a more exhaustive treatment of the limitations and possibilities of programming on a related problem see "Programming Structures in Watershed Development," by E. N. Castle, presented at T.V.A. Symposium, Economics of Watershed Planning, June 10-12, 1959. Proceedings to be published by the Iowa State College Press.

HIGHER EDUCATION AND SOVIET AGRICULTURE

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> The key to an understanding of the Soviet Union is its economic problem—the clash of economic development with consumer needs, and the race to catch up with the West.—CHARLES E. BOHLEN[1]

I. *Introduction*

A ROCKET is not a cucumber," Premier Khrushchev recently told a group of Russian farmers.[2] His terse statement reflects the fact that the U.S.S.R. is faced with a serious farm problem—a problem central to the growth of the Soviet economy. Faced on one hand with the need

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[1] Quoted by Daniel Schorr in "Bohlen Returns to the Russian Challenge," *New York Times Mag.*, October 18, 1959, p. 89.

[2] Edmund K. Faltermayer, "Farmer Khrushchev," *Wall Street Journal*, Aug. 10, 1959, p. 1.

to devote resources to the economic and military race with the United States, the Soviet government is also faced with urgent demands for more consumer goods. Not the least of these is the demand for more and higher quality food at lower prices.

But to move a nation of over 200 million people from a bread-and-potato diet to a level of per-capita food consumption comparable to the United States is not an easy matter. The production of more meat, eggs, milk, butter, fruits and vegetables requires heavy investments in labor and capital, as well as sharp adjustments in the organization of agriculture. Yet, the Soviets have made a serious attempt.

The past five years have seen many changes in Soviet agriculture: the machine tractor stations have been abolished, new procurement programs established, a cash labor payment program established, new lands opened up, electrification and mechanization increased, and expanded use made of fertilizers and new production techniques. These and many other changes have been well reported.[3]

However there is one sphere, vital to progress in Soviet agriculture, which has been almost completely overlooked. This concerns the very definite steps that the Soviet Union is taking to provide the well-trained cadre of agricultural personnel so necessary for progress in agriculture.

It is the purpose of this paper to discuss the developments in higher education in agriculture in the Soviet Union, to relate them to the needs and prospects for Soviet agriculture, and to suggest some economic implications.

II. *Higher Education*

In discussing higher education in the U.S.S.R., we turn first to the place of agricultural education, then to a consideration of the agricultural institutes and the courses of study.

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[3] U. S. Dept. of Agr., Technical Study Group Reports: *Economic Aspects of Soviet Agriculture,* May 1959, 78 pp.; *Soil and Water Use in the Soviet Union,* June 1959, 50 pp.; *Cotton in the Soviet Union,* June 1959, 16 pp.; *Crops Research in the Soviet Union,* Aug. 1959, 26 pp.; *Veterinary Science in the Soviet Union,* Oct. 1959, 50 pp.; *Mechanization of Agriculture in the Soviet Union. Comparisons of the United States and Soviet Economies,* Joint Economic Committee, U. S. Cong., Nov. 1959, Part I: D. Gale Johnson and Arcadius Kahan, "Soviet Agriculture: Structure and Growth," pp. 201-237; Nancy Nimitz, "Soviet Agricultural Prices and Costs," pp. 239-284; Lazar Volin, "Agricultural Policy of the Soviet Union," pp. 285-318; Part II: Charles B. Shuman, "An Agricultural View of the Soviet Threat," pp. 489-507. Grant Salisbury, "Another Look at Today's Russia," *U. S. News and World Report,* October 26, 1959, pp. 96-103. Artemy Shlikhter, "Certain Questions of Agricultural Competition Between the U.S.S.R. and the U.S.A.," *Mirovaya Ekonomika I Mezhdunarodnye Otnoshenia* (World Economics and International Relations), No. 9, September, 1959, pp. 33-51; condensed text in *The Current Digest of the Soviet Press,* October 7, 1959, pp. 3-8, 13. "The Economics of Shifting Farmers to Cash Payments," *The Current Digest of the Soviet Press,* July 15, 1959, pp. 9-17, 22.

Place of agricultural education[4]

Quantitatively, higher education in agriculture in the U.S.S.R. plays an important role, both internally and in comparison with the United States. In 1956, for instance, 26,200, or about 10 percent, of the 259,900 college graduates in the Soviet Union had studied "agriculture."[5] This compared with a total of about 8,500 "agricultural" graduates in the United States, approximately 2.7 percent of a total graduating class of 311,298.[6] Thus, in 1956 with only 84 percent as many college graduates as the United States, the Soviet Union produced about three times as many agricultural graduates.

A similar relationship held for college enrollments. During the 1954-1955 academic year, 132,200 students in the Soviet Union, or about 12 percent of the total regular student population of 1,087,000, studied agriculture.[7] On the other hand, in the United States agricultural enrollment of 36,163 students in 1953-1954 represented only 1.8 percent of the total resident enrollment of 1,976,863.[8] So, with about half as many college students as the United States, the Soviet Union had 3.7 times as many studying agriculture.

While the Soviet Union clearly has an edge over the United States in total numbers of agricultural students, this does not necessarily imply that the Soviets are ahead in another "educational race" because the basic

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[4] The figures reported in this section include undergraduate students only. The U.S.S.R. totals include veterinarians and specialists in conservation, electrification and mechanization of agriculture, and forestry. The U. S. figures, in order to be nearly comparable, include forestry and veterinary students (D.V.M. only) unless otherwise noted; they do not, however, include the relatively small number of undergraduates in such biological fields as entomology, plant pathology, plant physiology, bacteriology, etc. There may be other, unknown differences between the Soviet classification system and that in the U. S.

[5] Mikhail Kruglyansky "College Education in the Soviet Union," *USSR Illustrated Monthly*, No. 11 (26), Nov. 1958, p. 29. (Figures include graduates who had taken extension correspondence courses.)

[6] *Earned Degrees Conferred by Higher Educational Institutions 1955-1956*, U. S. Dept. of Health, Education & Welfare, Washington, May 1957, pp. 6-10. Covers period from July 1, 1955 to June 30, 1956. Land grant colleges and state universities reported 6,300 graduates in agriculture in 1956, exclusive of forestry and veterinary medicine; C. F. Simmons, "Data and Trends in Agricultural Enrollment," *Proc. Amer. Assoc. of Land Grant Colleges & State Universities*, 71st Ann. Convention, Washington, Nov. 1957, pp. 194-197.

[7] Nicholas DeWitt, *Soviet Professional Manpower, Its Education, Training and Supply*, National Science Foundation, Washington, 1955, pp. 298-299. (Figures do not include enrollment in extension correspondence courses.)

[8] "Statistical Summary of Education, 1953-54," *Biennial Survey of Education in the United States*, U. S. Dept. of Health, Education, and Welfare. Washington, 1957, Chap. 1, pp. 53-55. Tabulations of more recent total enrollments in agriculture in the United States not available (except for the land-grant institutions) at the time this paper was prepared.

TABLE 1. HIGHER EDUCATION IN AGRICULTURE—U.S.S.R.

Academic Year	Regular Enrollment	New Students Accepted	Graduates
1929–30	34,000	7,900	6,700
1934–35	61,300	24,700	8,800
1939–40	56,600	13,600	10,100
1946–47	60,300	16,000	8,000
1949–50	78,700	22,400[1]	12,000[2]
1954–55	132,200[3]	47,600	24,100[4]
1955–56	150,000[3]	51,100	26,200[4]
1956–57	169,000	48,700	29,800[4]
1957–58	222,000[5]	51,800	30,900[4]
1958–59	232,000[5]	56,600	34,000[4]

[1] 1950.
[2] 1951.
[3] In addition, 41,100 workers were enrolled in extension correspondence courses in 1954–55 and 45,900 in 1955–56.
[4] This figure includes students who had taken extension correspondence courses. In 1955, 1,100 of the graduates had been enrolled in such programs while the number reached 4,000 in 1959.
[5] Includes an unreported number of extension correspondence students.
Source: Nicholas DeWitt, *op. cit.* (text footnote 7), and data from forthcoming book by Dr. DeWitt, *Education and Professional Employment in the U.S.S.R.* See also: K. A. Ivanovich, *Sel'skokhoziaistvennoe Obrazovanie v SSSR* (Agricultural Education in the U.S.S.R.) Gosizdat (State Publishing House), Moscow, 1958, particularly pp. 7, 52; Vyacheslav Yelyutin, *Higher Education in the USSR*, International Arts and Sciences Press, New York, 1959, p. 19.

problems of agriculture are quite different in the two countries. Of greater concern should be the fact that in 1954-55, agricultural enrollments in the U.S.S.R. appeared to exceed those reported for the rest of the world combined.[9]

Moreover, if recent trends continue, higher education in agriculture in the U.S.S.R. may continue to grow even more in quantitative terms, for agricultural enrollments and graduates appear to be on the increase.

This is illustrated in Table 1. After a 20-year period of relatively slow growth from 1929 to 1949, agricultural enrollment suddenly increased 68 percent during the five-year period from 1949-50 to 1954-55. Acceptances increased 113 percent from 1950 to 1954, while the number of graduates increased 50 percent from 1951 to 1955. In addition, the number of agricultural graduates increased 41 percent from 1955 to 1959, bringing the yearly total up to 34,000.[10]

[9] Total reported enrollment in agriculture outside the Soviet Union (excluding Mainland China) was about 124,000 during the 1954-55 academic year. This was broken down as follows: U. S. 36,200, (1953-54); European Satellite nations 27,700; Japan 15,400; other nations 44,100. Compiled from *International Directory of Institutions for Higher Education in Agriculture*, Food and Agr. Org. of the U.N., Rome, Dec. 1957, and "Statistical Summary of Education," *loc. cit.*
[10] The 1959 total includes 4,000 graduates who had taken extension correspondence courses.

Proposals for higher agricultural education for the Seven-Year Plan from 1959 to 1965, presented at the 21st meeting of the Communist Party Congress, stated that the number of specialists trained in agricultural institutions should be increased by 50 percent in comparison with the preceding seven-year period. Very strong emphasis was placed on the need for expanding the already large program in correspondence and evening courses.[11]

Such expansion is not a random phenomenon, for according to the Minister of Higher Education, "Education of specialists in the Soviet Union is based on the estimates of future requirements in the respective branches of the national economy and cultural services."[12]

The agricultural institutes

In the Soviet Union most technical or applied education is carried on in institutes rather than universities. These institutes presume a general education in the secondary school and therefore concentrate largely on subject-matter material, such as engineering, agriculture, socioeconomics, education, and health and physical education. The universities, on the other hand, are more concerned with theoretical work in what we would consider the "arts and sciences."[13]

In 1954 there were 109 institutes for teaching agriculture and related subjects in the Soviet Union—an increase of 19 from 1949.[14] Of the total, 98 institutes were devoted to agriculture[15] and 11 to forestry.[16] Of the agricultural institutes, 23 specialized largely in veterinary medicine, zootechnology, animal breeding and related studies; 7 or 8 in mechanized or electrified agriculture; 6 in conservation;[17] one each in dairying, animal husbandry and horticulture; and the rest in general agriculture.[18] In addition, 11 state universities had faculties of soil science and four had faculties of agriculture.[19]

Enrollments for seven of the larger Soviet agricultural institutes during

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[11] *Soviet Seven Year Plan, 1959-65*, Todd Reference Books, London, 1959, pp. 35, 196.

[12] Vyacheslav Yelyutin, *Higher Education in the USSR*, International Arts and Sciences Press, New York, 1959, p. 19.

[13] Nicholas DeWitt, *op cit.*, pp. 89-93.

[14] *World Survey of Education*, Handbook of Education Organization and Statistics, United Nations Educational, Scientific and Cultural Organization, Paris, I (1955) p. 636; II (1958) pp. 1028-29.

[15] By 1959 the number had increased to 99. Vyacheslav Yelyutin, *op. cit.*, p. 19.

[16] K. A. Ivanovich, *op. cit.*, (source note, table 1), p. 7.

[17] Nicholas DeWitt, *op. cit.*, pp. 91-92.

[18] *International Directory of Institutions for Higher Education in Agriculture, op. cit.*, pp. 160-178.

[19] Vyacheslav Yelyutin, *op. cit.*, pp. 48-54.

TABLE 2. NUMBER OF AGRICULTURAL DEPARTMENTS IN INSTITUTES OF HIGHER EDUCATION, U.S.S.R., 1957

	Total
Agronomy	123
Animal industries	108
Mechanization	94
Veterinary science	33
Irrigation, conservation	25
Horticulture	24
Electrified agriculture	23
Agricultural economics	21
Farm management	16
Soil culture and agro-chemistry	8
Conservation	7
Silk culture	6
Forestry and other specialties	42
Total	530

Source: K. A. Ivanovich, *op. cit.* (table 1, source note), p. 46.

the 1954-55 academic year ranged from 2,300 to 5,000[20] and averaged approximately 3,300.[21] About 45 percent of the students were female,[22] just slightly less than the over-all average of 50 percent for all Soviet universities and institutes.[23] Teaching staffs averaged 278 full-time members, and ranged from 175 to 348.[24]

Most institutes have a number of departments. Agronomy or soil science is most numerous, followed by animal industries (see Table 2). The total number of these two departments exceeds the number of institutes and universities offering work in these fields, suggesting that some depart-

[20] *International Directory of Institutions for Higher Education in Agriculture, op. cit.* The seven U.S.S.R. institutes and their enrollments during 1954-55 were: K. A. Timiryazev Academy of Agriculture, Moscow;* 3,241; V. M. Molotov Institue for Mechanized & Electrified Agriculture, Moscow,* 2,287; C. M. Kirov Institute of Agriculture, Omsk,* 3,563; Leningrad Institute of Agriculture, Leningrad,* 3,074; Institute of Agriculture, Voronezh, 3,770; V. V. Dokuchaev Institute of Agriculture, Kharkov,* 2,291; Academy of Agriculture, Lvov, 5,023; (Those marked with asterisks are described in detail by K. A. Ivanovich, *op cit.*, pp. 55-69).

[21] The seven largest U. S. institutions and their agricultural enrollments (excluding veterinary and forestry) during 1955-56 were: Iowa State 1,899; Cornell 1,531; Ohio State 1,500; Pennsylvania State, 1,483; University of Missouri 1,364; Oklahoma State 1,306; Michigan State 1,255. The average enrollment was 1,477 and the proportion of women was 2.5 percent. C.F. Simmons, *loc. cit.*; "Statistical Summary of Education," *loc. cit.*

[22] *International Directory of Institutions for Higher Education in Agriculture, op. cit.*, pp. 168-176. Home economics is not a distinct discipline in the U.S.S.R. and it is possible that students receiving some training of this sort may be included in the reported agricultural enrollments.

[23] *Education in the U.S.S.R.*, U. S. Dept. of Health, Education and Welfare, Washington, 1957, p. 173.

[24] *International Directory of Institutions for Higher Education in Agriculture, loc. cit.*

ments may be located at research institutes or experimental stations.[25] On the other hand, the number of separate departments of agricultural economics and farm management appears to be relatively small. Some study and presumably teaching of the economics of agriculture is supposed to be done at the economics institutes but the work ". . . has been especially weak."[26]

Entrance requirements for the institutes include a secondary school education and passing of an oral and written entrance examination prepared by the particular institution. Among the subjects included in the examination are Russian language and literature, physics and chemistry.[27] Preference in admissions in the future is to be given to those who have had two or more years of practical experience.[28]

The school year runs from September 1 to June 30,[29] and for at least seven of the larger institutions five years of work is required for graduation. In addition, these institutions require 18 to 38 weeks of obligatory farm labor.[30] No fees are charged, and in fact, "More than 80 percent of the college students are paid state stipends which cover the required minimum standard of living."[31]

In September 1959, the U.S.S.R. Council of Ministers adopted a proposal encouraging collective and state farms to send their "most capable leaders in production" to higher educational institutions. The student's stipend is to be 15 percent higher than usual and will be paid by the sponsoring farm with the provision that the student return to that farm after graduation. It is felt that this program will give the workers ". . . incentives towards high indices in production work."[32]

The agricultural institutes were until recently administered by the Ministry of Agriculture[33] and the forestry institutes by the Ministry of Educa-

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[25] A display at the Soviet Exposition in New York during the summer of 1959 reported that agricultural research institutes in the U.S.S.R. include 7 academies of agriculture, 164 research institutes and 437 experimental stations. "The scientific staff of agricultural research establishments exceeds 18,800 and over 11,000 specialists carry on research at higher educational agricultural establishments."

[26] K. V. Ostrovityanov, Speech, *Pravda*, Feb. 6, 1959, p. 9. Quoted in *The Current Digest of the Soviet Press*, June 3, 1959, p. 16.

[27] Nicholas DeWitt, *op. cit.*, pp. 97-99.

[28] Mikhail Kruglyansky, *op cit.*, pp. 23, 24. Also see: "Education for Socially Productive Labor; The New School Law," *USSR Illustrated Monthly*, No. 5 (32), May 1959, p. 43; "New Entrance Rules for Higher and Technical Schools," *The Current Digest of the Soviet Press*, May 6, 1959, pp. 3, 4.

[29] Vyacheslav Yelyutin, *op. cit.*, p. 28.

[30] *International Directory of Institutions for Higher Education in Agriculture, loc. cit.*

[31] Vyacheslav Yelyutin, *op. cit.*, p. 27.

[32] "One More Step Toward Stronger Ties Between Higher Educational Institutions and Production," *Pravda*, p. 3, *Izvestia*, p. 2, Sept. 20, 1959. Quoted in *The Current Digest of the Soviet Press*, Oct. 21, 1959, p. 15.

[33] Vyacheslav Yelyutin, *op cit.*, p. 15.

tion,[34] but a decree issued during the summer of 1959 transferred jurisdiction of both to the Union Republic Council of Ministers.[35]

Eventually, it appears, the agricultural institutes will move entirely from the cities to large state farms.[36] The Central Committee of the Communist Party has stated, "The studies should be conducted at higher educational establishments organized on the basis of big state farms possessing extensive model instructional husbandries, good laboratories, and all the prerequisites for practical work."[37]

The course of study

Without first-hand observation it is not possible to evaluate the quality of the teaching at the various institutes, but it seems likely that considerable variation exists. This would probably be particularly true if a comparison were drawn, for instance, between the elite Timiryazev Academy in Moscow, which was founded in 1865, and some of the newer institutes which are being established in Siberia, Kazakhstan and the Far East.

In any case the curriculum, which is more or less standard throughout the country, appears to be rigid and rigorous. For example, a student in animal science (zootechnology) would be expected to take courses in the following 27 subjects; history of the Communist Party, political science, dialectical materialism, foreign language (English, German or French), fundamentals of higher mathematics, physics (including meterology), inorganic and analytical chemistry, organic chemistry, physical and colloidal chemistry, anatomy (with histology and embryology), Darwinism, botany, zoology, microbiology, animal physiology (with biochemistry), mechanization and electrification of agriculture, agronomy, animal breeding, animal feeding, animal hygiene, basic veterinary science, small animal husbandry, technique of animal products, agricultural economics, organization of socialist agricultural institutions, bookkeeping, and regional specialization. Numerous elective courses are also available.

In the course of his study, the animal science student has to pass 32 examinations and complete 38 papers and 6 course projects. Before graduating, he has to pass federal examinations in political science, animal production and the organization of socialist agricultural institutions; or, as an alternative, defend a thesis diploma.

Altogether, the course of study in animal science takes four years and

[34] K. A. Ivanovich, *op. cit.*, pp. 231, 234.

[35] "On Reorganizing the Administration of Higher and Specialized Secondary Educational Institutions in the U.S.S.R.," *Pravda* and *Izvestia*, June 27, 1959, p. 1. Quoted in *The Current Digest of the Soviet Press*, July 29, 1959, p. 18.

[36] V. N. Stolev, "On Higher Education," *Izvestia*, Apr. 15, 1959, p. 4. Quoted in *The Current Digest of the Soviet Press*, May 13, 1959, p. 15.

[37] *Soviet Seven Year Plan, op. cit.*, p. 239. Also see: "Education for Socially Productive Labor: The New School Law," *op. cit.*; and Vyacheslav Yelyutin, *op. cit.*, p. 43.

7 months, or about 241 weeks. Theoretical training accounts for about 132 weeks, practical training 46 weeks, examinations 31 weeks and vacations 32 weeks. Of the total of approximately 4,620 hours spent in formal study, about 1,770 are spent in lecture, 2,640 in laboratories and seminars, and 210 on papers. In the first years about 36 hours a week are spent in class, in the senior years this declines to 26 to 30 hours. The breakdown of time is roughly the same for all agricultural students but varies somewhat according to the school and major course of study.[38]

With the increased emphasis on state farm colleges, it may be that this curriculum will become somewhat less theoretical and more "practical." The Minister of Education has stated, "The faculty members of the agricultural colleges are confronted at present with the important task of strengthening contact between the educational process and production, of tying it up with the concrete features and urgent requirements of agriculture in the respective zones." "The main shortcoming is expressed in a certain aloofness from life, in the inadequate practical training of the school graduates."[39]

At the same time, more emphasis is being placed on agricultural economics. For instance, "There is a new interest in the theory and methodology of farm costs and cost investigations extending beyond single farms." In fact, Premier Khrushchev has remarked, "It is impossible to carry on farming without a thorough analysis of the cost of commodities being produced; and without control by means of the ruble."[40] At the 20th meeting of the Communist Party Congress, Khrushchev stated that young agronomists and engineers are not given enough training and knowledge in the fields of basic economics and the organization of Socialist agricultural institutions. Therefore, it was emphasized that "The improvement of economics education for specialists of agriculture should receive special consideration."[41] The 21st Congress went on to say that "All agricultural specialists must receive a good training in the economics and organization of socialist agricultural production."[42]

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[38] K. A. Ivanovich, *op. cit.*, pp. 78-79. For instance, an agronomy student at the Timiryazev Academy in Moscow would spend 4 years and 10 months or about 250 weeks in school. His training would be broken down as follows: theoretical 128 weeks, practical training 64 weeks, examinations 32 weeks and vacations 26 weeks. He would study 35 subjects and be expected to take 41 examinations, do 56 reports and 7 projects and take the federal examinations or defend a thesis.

[39] Vyacheslav Yelyutin, *op. cit.*, pp. 19, 42. For a commentary on the school reform in general, see letter by Nicholas DeWitt, *New York Times*, Oct. 23, 1959, p. 28.

[40] Lazar Volin, "Soviet Agriculture Under Khrushchev" (Enlargement of paper read at annual meeting of Amer. Econ. Assoc. Chicago, Dec. 27, 1958), Foreign Agr. Serv., U. S. Dept. Agr., p. 26. For detail on Soviet cost studies see Nancy Nimitz, *op. cit.*, pp. 256-262.

[41] K. A. Ivanovich, *op. cit.*, pp. 10, 11.

[42] *Soviet Seven Year Plan, op. cit.*, p. 239.

III. *Soviet Agriculture*

The need of Soviet agriculture for large numbers of trained personnel is great. This is due to problems of population and production, and is related to the need for labor.

Population

The number of workers engaged in agriculture in the Soviet Union is very large. While statistics are not entirely clear, it appears that the agricultural labor force in the U.S.S.R. totaled about 42.5 million in 1955,[43] over six times the U. S. figure of 6,730,000.[44] Thus, the ratio of trained agricultural graduates to individuals engaged in agriculture in the Soviet Union was about half as great as in the United States in 1955.[45] The relative shortage of graduates is aggravated by the fact that the Soviet system of agriculture involves more supervision and direction of labor. In addition, "There have been frequent complaints in the Soviet press of the wasteful use of agricultural specialists who are loaded with so much paper work and red tape that they could not devote enough time to their technical field."[46] On the other hand, the large size of the Soviet farms might lead to some efficiencies in the use of trained personnel.[47]

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[43] This estimate for the U.S.S.R. was obtained as follows:

a) Of the total working population of 85,000,000 in 1955, the 1957 *Economic Survey of Europe* (United Nations, Geneva, 1958, Chapter VII, pp. 60, 62) estimates that 36,600,000 were engaged in agriculture and forestry and (by induction) that 5,897,000 wage earners were employed in the "State Sector." Hence a total of 42,497,000.

b) The previous estimate seems to be confirmed by statistics provided in the *Yearbook of Labour Statistics* (International Labour Office, Geneva, 1958, pp. 159, 160). The report indicates that the proportion of the employed population in agriculture and forestry was 43 percent in 1955. If it can be assumed that the employed population was the same as the working population, we have an estimate of 36,550,000. To this are added 2,832,000 workers in suvkhozes and subsidiary agricultural enterprises and 3,058,000 at machine tractor stations (now abolished), for a total of 42,440,000.

It is possible that some of those listed under agriculture may be engaged at least part time in work outside of the usual concept of agricultural employment, such as in collective-farm processing, weaving or pottery plants.

[44] *Yearbook of Labour Statistics, op. cit.*, p. 149.

[45] This ratio does not include the large number of people serving agriculture who were trained in other fields. Inclusion of such persons might well alter this relationship.

[46] Correspondence from Lazar Volin, Foreign Agr. Serv., U. S. Dept. Agr., May 28, 1959. (Also see "Paper Whirlpool," *Current Digest of the Soviet Press,* Oct. 22, Nov. 5, 1958, pp. 20, 33.)

[47] For instance, "On January 1, 1958, there were 76,500 collective farms and 5,900 state farms in the Soviet Union, or a total of 82,400 farms. This compares with an estimated total of 4.8 million farms in the United States on the same date, of which about 2 million were full-time commercial farms." Thus, the number of farms in the U.S.S.R. was only 1.7 percent of the total number of farms and 4 percent of the number of full-time commercial farms in the U.S. *Economic Aspects of Soviet Agriculture, op. cit.*, p. 10. Also see Lazar Volin "Soviet Collective Farms Become Fewer But Larger", *Foreign Agriculture,* October 1959, pp. 17, 18.

In any case, agricultural productivity per worker in the Soviet Union is generally recognized to be low—much below that in the United States.[48] This is reflected in the fact that the agricultural labor force in the U.S.S.R. in 1955 (including the state sector) represented about 50 percent of the total labor force—as opposed to a comparable figure of slightly more than 10 percent in the United States. The Soviet Union is keenly aware of this situation and in fact Premier Khrushchev conceded during his recent visit to the United States that ". . . your output per person employed in agriculture is, of course, much higher than on our collective farms."[49]

Production

The combination of large numbers of workers in agriculture with low productivity stands at the heart of the central agricultural problem in the Soviet Union—the expansion of the production of food and fiber. A technical study group of agricultural economists who visited the Soviet Union during the summer of 1958 reported:[50]

> The fact that the population of the Soviet Union is not only growing rapidly at present, but also is becoming increasingly urbanized with the industrial development of the country . . . accentuates the need for greater farm output. For urbanization not only decreases the manpower on farms, but it normally brings with it a desire for higher quality diets. These diets require increased supplies of animal and dairy products, sugar, vegetables and fruits. Political and psychological factors also have made more urgent the long promised improvement of living levels.

Under the new Soviet Seven-Year Plan, "One of the most important tasks proposed for agriculture is a rise in labor productivity and a decrease in production costs."[51] Specifically, labor productivity is to be in-

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[48] This point is well illustrated in the 1958 *Economic Survey of Europe* (United Nations, Geneva, 1959) which on p. 18, Chap. I, provides a comparison of farm man-hours per unit of output and area between the U.S.S.R. and the United States. Similar data is provided in an article by Lazar Volin, "Khrushchev and the Recent Soviet Agricultural Developments," *Foreign Agriculture*, April 1959, pp. 3, 4, 14. Additional information is noted by: Irving R. Levine, *Main Street, U.S.S.R.*, Doubleday & Co., Inc., New York, 1959, pp. 113-139; Andrew G. Frank, "Labor Requirements in Soviet Agriculture," *The Review of Economics & Statistics*, Harvard University Press; Cambridge, May 1959, pp. 178-182; and Arcadius Kahan, "Changes in Labor Inputs in Soviet Agriculture," *J. Pol. Econ.*, Oct. 1959, pp. 451-62.

[49] "Text of Khrushchev Speech at Des Moines Dinner," *New York Times*, Sept. 24, 1959, p. 23. (According to Soviet writer Artemy Shlikhter, ". . . . 100,000 to 150,000 U. S. farmers are ruined anually and forced out of agriculture without any hope of finding a secure position in other branches of the economy." *Op. cit.*, p. 13.)

[50] *Economic Aspects of Soviet Agriculture, op. cit.*, p. 2. Also see: "Soviet Living Standards," *The Economist*, Aug. 29, pp. 618-619, Sept. 5, pp. 713-714; Oleg Hoeffding, "Substance and Shadow in the Soviet Seven Year Plan," *Foreign Affairs*, Apr. 1959, p. 404.

[51] "Twenty-First Congress Adopts Seven-Year Plan," *USSR Illustrated Monthly*. No. 3 (30), Mar. 1959, p. 3.

creased 100 percent on the collective farms and 55 to 60 percent on the state farms.[52]

To further these goals, it is probably of most immediate significance that "The total capital investments in agriculture by the state and collective farms will . . . amount to about 500,000 million rubles in 1959-65 and will be nearly double the investments made in 1952-58."[53] This investment will largely take the form of increased electrification, mechanization and fertilization.[54] At the same time however, the target figures ". . . hinge upon education since larger numbers of trained people in all the farm specializations will be needed."[55]

If through these methods the U.S.S.R. is able to increase productivity per worker to the point where the same proportion of its population is engaged in agriculture as existed in the United States in 1955, approximately 34 million people would theoretically be freed for other work.[56]

Need for labor

That labor is needed in other fields is clear. A United Nations economic survey reports that ". . . the slowing down of the rate of growth of the active population, combined with the appearance of obstacles to further transfers from agriculture has led, at least temporarily, to a situation unusual in the Soviet Union in which the size of the available labor force becomes a factor limiting the growth of the economy."[57] Indeed, as one Soviet publication states, "The country's expanding industry not only has absorbed all the manpower available, but its need for labor has never been satisfied."[58] Another publication continues, "Labor scarcity has been

[52] Artemy Shlikhter, *op. cit.*, p. 13.

[53] *Soviet Seven Year Plan, op. cit.*, p. 168. Edwin L. Allen, Central Intelligence Agency, reports, "There is . . . no doubt that there has been a diversion of investment funds in the Soviet Union away from heavy industry to agriculture." *Soviet Progress vs American Enterprise*, Doubleday & Co., Garden City, 1958, p. 86.

[54] Artemy Shlikhter, *op. cit.*, pp. 3-8, and Grant Salisbury *op. cit.* p. 103. The need for increased capital investment in machinery is stressed by Irving R. Levine, *op. cit.*, pp. 114-115, while current developments are discussed by Karl D. Butler in "Russian Farm Equipment," *The Farm Quarterly*, Autumn 1959, pp. 42-47, 124-125.

[55] "Target Figures for an Economy of Plenty," *USSR Illustrated Monthly*, No. 1 (28) Jan. 1959, p. 6. More general aspects of Soviet agriculture are discussed by: Lazar Volin, "Soviet Agriculture Under Khrushchev," *op. cit.*; Rudolf Schleshinger, "The New Structure of Soviet Agriculture," *Soviet Studies*, Basil Blackwell, Oxford, Jan. 1959, pp. 228-251; Harry Schwartz, *Russia's Soviet Economy*, Prentice Hall, Inc.; New York, 1954, pp. 294-388; and Irving R. Levine, *op. cit.*, pp. 113-139.

[56] For a popular discussion of what such a shift implies see E. T. York, Jr., "Are We Losing Another Race to the Russians?" *Better Crops With Plant Food*, Amer. Potash Inst., Washington, Dec. 1957, pp. 24-27. Also see W. L. Gibson, Jr., *Research and Education in Agriculture*, Va. Poly. Inst. Ext. Bull. 260, Mar. 1959, p. 15.

[57] *1957 Economic Survey of Europe, op. cit.*, p. 51. Also see Oleg Hoeffding, *op. cit.*, p. 399.

[58] Mikhail Sukhanov, "The Soviet Farmer and Machine Power," *USSR Illustrated Monthly*, No. 5 (20), May 1958, p. 46.

a worrisome problem for Soviet industry and agriculture for a considerable time now. With the scope and magnitude of construction and development now going on as part of the seven-year plan, it has become even more acute." "Where are 12 million workers to man the new enterprises to come from? That is the large-sized problem Soviet planners are trying to solve."[59]

Despite this need, however, it seems questionable whether much labor can be shifted out of agriculture at this time if the ambitious plans to increase gross farm output 70 percent by 1965 are to be carried out. A Soviet publication reports that in general ". . . the collective and state farms, in constant process of expansion, could use considerably more workers than they have." This is probably because much of the increase in productivity is to be concentrated in such labor-using programs as a substantial increase in cattle and other livestock numbers, and increased production of cotton, sugar beets, fruits and vegetables.[60]

Therefore, if the Soviet Union is even to approach its various long-run economic goals, increased productivity per farm worker is essential[61]—as is perhaps indicated by the fact that during the tense start of the Foreign Ministers meeting in Geneva in May Premier Khrushchev was in the Ukraine and Moldavia inaugurating a campaign to improve the use of labor in Soviet agricultural production.[62]

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[59] Mark Postolovsky, "Needed: Another 12 Million Workers," *USSR Illustrated Monthly*, No. 8, (35), Aug. 1959, pp. 23, 26. It is quite possible that such shortages have encouraged the school reform bill and perhaps some demobilization of the armed forces.

[60] "U.S.S.R.'s New 7-year Plans to Up Farm Output 70%," *Foreign Agriculture*, Jan. 1959, p. 11; Artemy Schlikhter, *op. cit.*, p. 3; Oleg Hoeffding, *op. cit.*, p. 400. The quote is from Mark Postolovsky, *op. cit.*, p. 26. The Central Intelligence Agency doubts that the increase in agricultural production by 1965 will exceed 18 to 20 percent. Allen W. Dulles, statement to Sub-committee on Economic Statistics, Joint Economic Comm., U. S. Cong., cited in *U. S. News and World Report*, Nov. 23, 1959, pp. 97-99. The program for increasing fruit production is discussed by this writer in "Some Economic Aspects of the Soviet Fruit Industry," *International Fruit World*, Basle, Autumn 1959, pp. 345-367.

[61] Artemy Shlikhter, *op. cit.*, p. 3. An indication of the need and opportunities for improved utilization of labor in agriculture is found in the following note made by Rudolf Schleshinger in reviewing *Voprosy Razmeshchenie I Spetsial Izatsii Selkkove Khozyaistva* (Problems of Distribution and Specialization of Agriculture) Selkhozgiz, Moscow, 1957: "Nemchinov calculates that with the mechanization existing in 1953, 16.4 workers were needed per 100 hectares of land and that fulfillment of the long-term plan requires an increase of that figure to 20.4; with application of the best technique known at the time, however, the 1953 results could have been achieved by 7.2 workers per hundred hectares and the long term prospects by 9.3 workers per hundred hectares, i.e. by less than 60 percent of the labor force needed in 1953." *Soviet Studies*, Basil Blackwell, Oxford, July 1958, p. 83.

[62] "Khrushchev Asks Savings in Labor," *New York Times*, May 14, 1959, p. 5; Harrison E. Salisbury, "Khrushchev Sees Food Output Gain," *New York Times*, May 16, 1959, p. 3.

IV. *Summary and Conclusions*

The Soviet Union faces the important economic problem of increasing production in agriculture. Despite thirty years of intensive economic planning, total agricultural production remains less than desired, and production per worker is much less than in the United States. Thus, a large proportion of the labor force—badly needed in other sectors—remains in agriculture, limiting the growth of the economy.

The problem, then, is one of increasing productivity. In the effort to increase the rate of economic growth the Soviet Union must sharply increase productivity per agricultural worker. This will permit increased total agricultural output and will free workers for other areas of the economy.

But how can agricultural productivity be increased? One basic method is to increase capital investment in both the physical and social phases of agriculture. The forms of physical investment include such relatively obvious factors as (1) labor-saving farm machinery, (2) production-increasing techniques such as fertilizer and irrigation, or (3) laboratories and scientific equipment for the development of machinery and technology. Less obvious but equally important, however, capital investment must also be made in social capital—in the human beings who through research, teaching, extension, planning, and management will be at the forefront of any progress in agriculture.

Therefore, the element of skilled human resource becomes a key factor in the economic development of the Soviet Union. This is reflected in the government policy of expanding higher education in agriculture. Moreover, the quality of the curriculum from the viewpoint of physical science appears to be very high. However, the program in the social sciences is less impressive. Little seems to have been done to provide adequate training in economics and administration to those who would manage the huge collective and state farms. It appears likely that in the future considerable growth will take place in the field of agricultural economics, particularly farm management.

Assuming a balance is struck between education in the social and in the physical sciences in agriculture, the results conceivably could be most impressive. Ample trained manpower would be available for the development and application of improved technology—leading to increased production per worker. This would help accomplish the previously mentioned goals of increasing agricultural production and freeing manpower for other labor-short sectors of the Soviet economy. An expansion of food supply to levels comparable to the United States could be of tremendous propaganda value, while increased availability of labor could act as a powerful stimulus to economic growth.

Further, as the institutes begin to catch up to the personnel needs of Soviet agriculture they could turn more attention to training large numbers of agriculturists from the satellite and/or underdeveloped countries, and could provide these countries with a tremendous reserve of technical assistance. If the cold war continues, this could be a factor of no little importance.

Whether or not the Soviet Union will accomplish its goals for agriculture, no one can say. But in the light of Premier Khrushchev's boast that the Soviet Union will beat the United States on economic as well as scientific grounds, it seems clear that Soviet higher education in agriculture may indeed play a role of international importance.

MODELS OF THE LAND MARKET—A NOTE

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IN "Land Values as Measures of Primary Irrigation Benefits,"[2] J. W. Milliman discusses several conceptual and practical problems that were abstracted from my original paper on the subject.[3] While some of the difficulties in using land values as a measure of irrigation benefits may seem formidable—especially the difficulty of obtaining reliable data on land values and related investment—I should not like to see a discussion pertaining to "the relevance of the measure" obscure the more important aspect of the paper.[4]

Regardless of one's predilection as to the standard that should be used in appraising reclamation investments, there is a sense in which the land value and the budget study approaches to benefit estimation are com-

[1] The opinions expressed in this paper are those of the author and do not necessarily represent the views of the Farm Economics Research Division, ARS, or the U. S. Department of Agriculture.

[2] Milliman, J. W., "Land Values as Measures of Primary Irrigation Benefits," *J. Farm Econ.*, 41: 234-43, May 1959 (Univ. of Cal., Col. of Agr., Giannini Found. of Agr. Econ. Paper 175).

[3] Renshaw, Edward F., "Cross-Sectional Pricing in the Market for Irrigated Land," *Agr. Econ. Res.*, 10:14-19. Jan. 1958.

[4] My interest in models of the land market grew out of a discovery that there exists a difference between benefit estimates for reclamation projects based on land and water values as opposed to budget study estimates made by the various project agencies. Benefit estimates may differ by a factor of four or more. Renshaw, *Toward Responsible Government; An Economic Appraisal of Federal Investment in Water Resource Programs* (Chicago: Idyia Press, 1957), p. 114. While it is perhaps unfair to attribute this inconsistency to the statistical procedures used in calculating benefits, it does seem clear that a very different standard is used to justify public investment in reclamation as opposed to private development.

plementary. The "crop value index," for instance, serves to highlight the sensitivity of benefit estimates to assumptions about cropping pattern. A recent study of Tolley and Freund suggests that "type of agriculture" assumptions are also the most sensitive assumptions in budget study analyses of watershed protection benefits.[5]

As good analysts are the scarcest resource in the water resource area, it makes sense to discover the directions that promise the greatest payoff from analytic effort.[6]

The value of Milliman's criticisms of the land value approach to benefit estimation, it seems to me, is in highlighting difficulties that can be either avoided by a judicious selection of basic data or incorporated into models of the irrigated land market via additional variables. Until we obtain a comprehensive empirical model, it will be impossible to determine the relative importance of his criticisms.

The real justification for an interest in models of the land market, however, lies outside reclamation. Save for a growing interest in "unjust enrichment" or "unearned increments" that become capitalized into land values, project planners are not likely to be interested in the land value approach;[7] the difference in public and private standards for determining investment is simply too great.[8] In other areas, however, one can detect a growing interest in empirical models of the land market. These uses, along with the considerable amount of work that has been published in obscure places, bear mentioning.[9]

During the 1920's and early 1930's, Chambers,[10] Haas,[11] Ezekiel,[12]

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[5] Tolley, George S., and Ralph A. Freund, "Does the State of the Data Suggest a Program for Modifying Planning and Evaluation Procedures?" presented at the Symposium on the Economics of Watershed Planning, Knoxville, Tennessee, June 10-12, 1959, sponsored by the Southeast Land Tenure Res. Com., TVA, and the Farm Foundation.

[6] A hope of the econometric approach to land valuation is that an analyst will be able to embed his insights and discoveries into a set of equations and by so doing permit a greater division of labor between research and routine handling of data. It is not unreasonable to expect that a good model of the land market would have the labor-saving potential of an invention in dealing with many problems; as such, it would provide a way of increasing the productivity of the economic profession.

[7] Unjust enrichment has recently become a political issue in California in connection with the Feather River Project.

[8] Renshaw, "An Ecoonmic Appraisal of Public Investment in Water Resource Programs," to be published in *Modern Land Policy* by the Univ. of Ill. Press.

[9] Elsewhere, I have attempted a more detailed summary of the literature pertaining to the use of land market models in the area of appraisal and assessment. See Renshaw, "Scientific Appraisal," *Nat'l. Tax J.*, 11:314-22, Dec. 1958.

[10] Chambers, Clyde R., *Relation of Land Income to Land Value* (Washington: Govt. Print. Off., 1924), 132 p. (U. S. Dept. of Agr. Departmental Bul. No. 1224); and "Relation of Farm-Land Income to Farm-Land Pricing," *Amer. Econ. Rev.*, 14:673-98, Dec. 1924.

Wallace,[13] Wiecking,[14] and Tennant[15] became interested in the complex factors that affect land values.[16] In summarizing the results of these pioneering efforts to isolate the determinants of agricultural land values, Flood concluded:

> The studies . . . provide us with rather conclusive evidence that farm prices may be expressed linearly in terms of certain well chosen variables and with reasonable accuracy . . . the method of least squares can be used on this type of problem with some confidence.[17]

In one case that can be cited, it is known that statistical methods were used in assessing forest land.

> In the town of Louden (New Hampshire) the appraised values of the land, exclusive of buildings, were computed by means of a statistical formula. This formula took into account the principal factors affecting value and was based on values of 134 individual properties, as determined by one of the same expert appraisers who was responsible for the individual appraisals in Freemont and Richmond. . . .[18]

Recently, the Canadian Department of Agriculture has published a study by D. M. Warren on factors associated with land values in the proposed South Saskatchewan River Development.[19]

Growth in both the amount of state aid and the proportion of it that is distributed according to some principle of "equalization" has encouraged a number of prominent educators to seek a better index of taxpaying ability than is obtained from local assessments. Cornell, Johns, McLure, MacConnell, and Lee have been instrumental in getting accepted, in a

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[11] Haas, G. C., "Assessment of Farm Real Estate," *Proceedings of the Sixteenth Ann. Conf. on Taxation* (New York: Nat'l. Tax Assoc., 1924), pp. 63-114.

[12] Ezekiel, Mordecai, *Factors Affecting Farmers' Earnings in Southeastern Pennsylvania* (Washington: Govt. Print. Off., 1926), 64 p. (U. S. Dept. of Agr. Bul. 1400).

[13] Wallace, Henry A., "Comparative Farm-Land Values in Iowa," *The J. of Land and Pub. Util. Econ.*, 2:385-92, 1926.

[14] Wiecking, E. H., "Factors Determining the Value of Farm Real Estate in the United States," *Proc. of the Second Internat'l. Conf. of Agr. Economists* (Menasha, Wisconsin: George Banta Pub. Co., 1930), pp. 1012-1024.

[15] Tennant, J. L., *The Relationships Between Roads and Agriculture in New York* (Ithaca, New York: 1929). (Cor. Univ. Agr. Exp. Sta. Bul. 479.)

[16] In this connection should be mentioned an article by George, James P., "Correlation Analysis of Farm Land Values," *J. Farm Econ.*, 23:668-71, Aug. 1941. I am indebted to Douglas Dacy for calling my attention to the articles by Chambers, George, and Blaich and to William Pendleton for the article by Thomsen.

[17] Flood, Merril M., *Scientific Assessment Procedure* (Princeton: 1937). (Princeton Local Gov't. Surv., Supporting Memo. No. III (D) to accompany Pocket Rept. Ser. No. III: *Readjusting Local Services and Areas.)*

[18] Fairchild, Fred Rogers, and Associates, *Forest Taxation in the United States* (Washington: Govt. Print. Off., 1935), p. 112. (U. S. Dept. of Agr. Misc. Publ. 218.)

[19] Warren, D. M., *A Study of Factors Associated With Land Values in the Proposed South Saskatchewan River Development* (Ottawa: Can. Dept. of Agr., Dec. 1954).

few states, indexes of relative taxpaying ability. Typically, the indexes are constructed by correlating various published statistics of an economic character with some reliable measure of aggregate property value. Factors such as retail sales; proceeds from passenger automobile license sales; personal income tax returns; value of farm products; the number of gainfully employed nonfarm, nongovernment workers; and the percentage of public utilities are commonly included in the models used to determine local taxpaying ability.[20]

One of the most fascinating uses to which models of the land market can be put is in testing hypotheses about the effect of various public policies on land values.[21] Gilbert Dementis, in his study of migrant Mexican labor entering illegally into three Texas counties, has demonstrated that a large part of the gain from "wetback" labor was capitalized into land values.[22]

Models of the land market are interesting for their own sake. A general empirical theory of the land market would provide clues as to its rational functioning[23] and increase our understanding of the role of land as a factor of production. Research has progressed to the point at which it is only a matter of time until someone will come up with a measure of "speculative influence."

While research on land values is both frustrating and costly, it holds promise of being rewarding. The work of Muth suggests that we are on the verge of obtaining a general model of the land market that will encompass urbanization as well as rural land values.[24]

Drawing upon the work of traffic engineers and the social physicists,

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[20] For a discussion of what has been done in this area, see: Johns, R. L. and Herbert A. Meyer, "Distributing State Funds, How to Estimate Taxpaying Ability of Local School Units," *The Nation's Schools*, 49:49-50, Feb. 1952; Nat'l. Conf. of Professors of Educ. Admin., *Problems and Issues in Public School Finance* (New York: Teachers College, Columbia Univ., 1952), pp. 221-230; and Renshaw, *The Expenditure Effect of State Aid to Education* (Chicago: Univ. of Chic. Office of Agr. Econ. Res. Paper No. 5808, May 5, 1958).

[21] In my "Reclamation and the American Sugar Policy: A Case of Compounding Resource Misallocation," *Western Political Quarterly*, vol. 10:862, Dec. 1957, I made use of a model of the irrigated land market to test the hypothesis: Has the sugar-control program caused irrigated land values to be higher than they would have been without the program.

[22] Dementis, Gilbert, unpub. Ph.D. thesis, Univ. of Chic.

[23] In addition to Renshaw, "Are Land Prices Too High: A Note on Behavior in the Land Market," *J. Farm Econ.*, 39:505-10, May 1957, attention should be called to a much earlier article by Thomsen, F. L., "Factors Affecting Farm Real Estate Values in the United States," *J. Farm Econ.*, 17:379-82, May 1935, and to a more recent article by Blaich, O. P., "The Minnesota Land Value Problem," *Rept. of the Governor's Study Comm. on Agr.*, 1958, Univ. of Minn.

[24] Muth, Richard, "Economic Change and Urban vs. Rural Land-Use," accepted for publication by the *Rev. of Econ. and Stat.*

Hansen has shown the possibility of constructing plausible indexes of accessibility.[25] He found these indexes to be highly correlated with residential development. An inspection of Homer Hoyt's data for Chicago reveals high correlations between land values and distance from the central business district.[26] It seems probable that the population effect which I found puzzling in my early investigations of the irrigated land market can be rationalized in terms of accessibility.[27]

On the basis of these and other scattered bits of evidence, it seems safe to predict that accessibility will figure prominently, not only in future models of the land market but in the testing of location theories; the burst of empiricism which brought traffic models into operational use by planners might be responsible for revolutionizing the theory and practice of land economics.

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[25] Hansen, Walter G., "How Accessibility Shapes Land Use," *J. Amer. Inst. of Planners*, 25:73-6, May 1959. By way of further comment, it might be noted that this entire issue of *J. Amer. Inst. of Planners* was devoted to land use and traffic models. The article by Blumenfeld, "Are Land Use Patterns Predictable?" will be of special interest to individuals wishing to construct models of the urban land market.

[26] Hoyt, Homer, *One Hundred Years of Land Values in Chicago* (Chicago: Univ. of Chic. Press, 1933).

[27] Renshaw, *Toward Responsible Government* . . ., pp. 154-158.

LAND VALUES—A FURTHER COMMENT

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IN THE preceding note, Edward F. Renshaw comments upon my paper[1] and points in optimistic fashion toward the possibility of increased use of models of the land market for empirical research in appraising the effects of alternative kinds of public and private investment. My own study of the problem has lead me to be somewhat less enthusiastic. Perhaps the major difference between us lies in Renshaw's belief that a generalized econometric approach to land valuation problems is just around the corner. Although I share the hope for the emergence of such a model I have seen little to date which indicates its immediate likelihood.

Nevertheless there seems to be an increasing awareness that increases in land values may reflect capitalization of economic gains arising from the use of inputs which are priced below their economic worth. It is now becoming clear that the subsidized provision of many public services, os-

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[1] J. W. Milliman, "Land Values as Measures of Primary Irrigation Benefits," *J. Farm Econ.*, 41:234-43, May 1959.

tensibly designed to modify the existing distribution of income, may not in fact achieve the desired results in so far as economic "surpluses" from the use of the "free" service become capitalized in the form of higher prices (costs) for complementary inputs which are inelastic in supply. The provision of public health subsidies, for example, may not really lower the total cost of medical care to the recipients if the economic benefits are transformed into higher economic rents for specialized, strategic inputs in the supply of medical services. It is well established that "cheap" water in Western reclamation projects may be largely offset by higher land prices so that irrigators gain only in so far as they are land owners. As I pointed out earlier,[2] there is no *a priori* reason, however, why economic surpluses from subsidized irrigation water must be capitalized in land values; higher land values are only one of the various possibilities for capitalizing surpluses.[3]

I am somewhat surprised by Renshaw's implication that the "vastly different standards" used in public and private investments (particularly for reclamation projects) are somehow related to the choice of methods for project valuation, in this case the use of the "budget" method as compared to the "land values" method. Although divergent standards are present, it is not clear what this has to do with the "land values" approach. There is nothing intrinsic in either of the methods in their pure forms which necessarily produces a variation in the implied stringency of the valuation test. That is to say, both methods of project valuation can be abused; both can be given a conservative cast. It does not seem fair to imply that, because *ex post* land values (computed by Renshaw) are lower than *ex ante* benefits calculated by the "budget" method, the difference is due to the *method* used for estimating benefits. It is quite likely that *ex post* calculations by the "budget" method would reveal a similar discrepancy between anticipated and realized benefits.

The important point is that the "budget" and "land values" methods of project valuation are alternatives which have comparable difficulties and deficiencies. Both methods can be employed in *ex ante* and in *ex post* situations; each can be used to check upon the other. Perhaps the formidable difficulties of the "land values" approach can be reduced, as Renshaw suggests, by judicious selection of data and by the incorporation of additional variables in the land market model, but I am skeptical of the view that it can ever be more than an imperfect method of measuring project benefits.

[2] Milliman, *op. cit.*, p. 239.

[3] For an excellent discussion of the relation between capital values and costs see: Armen Alchian, "Costs and Outputs," *The Allocation of Economic Resources—Essays in Honor of Bernard Francis Haley*, Stanford U. Press, 1959, pp. 36-39.

WEATHER INDEXES*

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THE need for some measure of the influence of weather to aid and improve analysis and estimation of economic relationships has been expressed many times. To study the influence of a particular economic variable on supply of a particular crop, for instance, it is desirable, if not necessary, to be able to measure or account for the influence of other variables such as weather. Weather is often the most important variable influencing yield and production of a crop. A particular instance which prompted the computing of the indexes in this article was a study by W. A. Cromarty.[1] In his models for supply of wheat, feed grains, soybeans, tobacco, and cotton, there was a need for some measure of the influence of weather. In an attempt to meet the need for a measure of the influence of weather on agricultural output expressed by Cromarty as well as others, the author constructed indexes of the influence of weather on production of specific crops and various aggregate measures of agricultural production and yield. Since these indexes were constructed, several persons have indicated that they found them useful.[2]

Indexes of the influence of weather were constructed for corn, oats, barley, wheat, soybeans, cotton, and tobacco. Indexes were also constructed for the influence of weather on important aggregate measures of United States agricultural production and yields, including the indexes of Crop Production, Gross Farm Production, Farm Output, Marketings and Home Consumption, and Crop Yields per Harvested Acre. In addition, indexes were constructed for the feed grain components of the indexes of Crop Production, Farm Output, Marketings and Home Consumption, and Yields per Harvested Acre.

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* Journal Paper No. 129, The New Mexico Agricultural Experiment Station. This article reports some results of the author's Ph.D. thesis, *Indexes of the Influence of Weather on Agricultural Output*, Michigan State University, 1958. The author wishes to express particular thanks to Dr. Glenn L. Johnson for helpful suggestions during the writing of the thesis. The author also wishes to express his appreciation to Dr. W. A. Cromarty and Dr. R. Gustafson of the Department of Agricultural Economics, Michigan State University for helpful suggestions in writing this note.

[1] See Cromarty, W. A., *Economic Structure in American Agriculture*, Unpub. Ph.D. thesis, Dept. of Agr. Econ., Mich. State Univ., 1957.

[2] Note especally the use made by Hathaway in "Agriculture in an Unstable Economy Revisited," *J. Farm Econ.*, Aug. 1959. Cromarty has also used these indexes in recomputing parameters for his supply equations, and reports in a recent letter that the "indexes consistently help to explain the variance in production" for various crops.

Procedure and Assumptions

The conceptual framework for measuring the influence of weather on crops in this study was similar to that used by Johnson[3] and Hathaway.[4] It was assumed that if time series of yields for the studied crops could be obtained from experimental plots in the areas where the particular crops were grown and where as many variables as possible had been held constant, then the remaining variation in yield from year to year would give an indication of the influence of "weather" after trend had been removed to account for increases or decreases in fertility level in the soil.

Actually, only part of the variation in plot yields (after trend has been removed) can be explained by direct weather influences. The part not due directly to weather influences can be classified as variation due indirectly to weather and variation unrelated to weather. Examples of factors causing variation in yields which may indirectly be related to weather include such things as insect damage, plant disease, and soil moisture levels. Examples of factors causing variation in yields which may not be related to weather include such things as variations in seed and fertilizer application, cultural practices (including management), crop damage by certain pests, various accidental occurrences, and other factors which cannot be accounted for. All direct and indirect influences of weather in this study were called the influence of "weather". It was assumed that all variations in plot yield due to non-weather factors not correlated with weather were randomly and normally distributed with an expected value of zero. Thus the influence of weather as measured by these indexes includes not only influences of various direct components of weather such as rainfall, sunshine, etc., but also indirect influences: insects, disease, and other.

It was assumed further that the trend due to fertility increases or decreases was approximately linear and could be removed by the standard statistical method of fitting a regression line of yield on time and measuring deviations from the computed annual yields. Indexes were thus computed for specific crops at particular locations by dividing the actual by the computed yield for each year. Following this, indexes at each location were weighted together, using production figures for the area represented by each location, into an index for the whole United States for each crop. Indexes for the various aggregate measures were then constructed by weighting indexes for each crop contained therein by the value of production of each during the chosen base period, 1947-49.

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[3] Johnson, G. L., *Burley Tobacco Control Programs,* Ky. A.E.S. Bul. 580, Feb. 1952.

[4] Hathaway, D. E., *The Effects of the Price Support Program on the Dry Bean Industry in Michigan,* Mich. A.E.S. Tech. Bul. 250, Apr. 1955.

The indexes of the influence of weather were computed from time series data for the various crops from experimental plots located in the more concentrated areas of production. Series were obtained in which as many variables as possible affecting yield (except weather influences) had been held constant. Variables held constant included crop variety, soil, certain cultural practices, and others. The general procedure was as follows:

1. Trend was removed from each separate series for each crop at each location by fitting a linear regression line to the data. This was done to remove the influence of increases or decreases in soil fertility due to the particular treatment for each experimental plot.

2. Indexes for each series were computed as the ratio of the actual to the computed yields of a linear regression.

3. Indexes for each series for each crop at each location were averaged for overlapping years to obtain an index for each crop at each location. This involved much subjective screening of data, consideration of whether or not there were weather cycles, splicing shorter series together and other difficulties. Construction of these indexes involved making various guide-rules and assumptions as difficulties arose. Some of these were as follows:

a. If series were no longer than five years, trend was not removed. Deviations from the average were used instead. Such series were used only when longer series could not be found for the particular purpose.
b. If weather cycles appeared to exist, as detected by computing moving averages at various locations, the beginning and ending points for each series were chosen so as to connect similar stages of the cycle or, in general, efforts were made to avoid short-run trends due to cycles which did not reflect the longer-run trend of increases or decreases in soil fertility.
c. Indexes for each year at each location were checked against each other, against county, state, or U. S. average yields and against various other measures such as unharvested acreage, rainfall, etc., which would reflect the influence of weather on yield to some extent. When individual figures looked irregular by comparison, the original source of data was rechecked for mistakes or for various disturbances at each location which might have caused the suspected irregularity. Many such irregularities were eliminated from the data by this method.

4. Indexes for each crop at each location were weighted together into an index for the particular crop for the United States, using as weights the 1947-49 average production for the area represented by the location.

TABLE 1. INDEXES OF THE INFLUENCE OF WEATHER ON PARTICULAR CROPS, U.S., 1900–1957

Year	Corn	Oats	Barley	Wheat	Soybeans	Cotton	Tobacco
1900	80.1	199.0	—	177.5	—	154.8	—
1901	81.8	8.2	—	138.8	—	162.5	—
1902	181.0	105.4	—	108.1	—	114.0	—
1903	104.0	—	—	135.8	—	128.1	—
1904	80.7	70.3	—	66.0	—	120.7	—
1905	129.9	116.4	—	50.3	—	119.9	—
1906	105.1	109.6	—	79.0	—	104.0	—
1907	114.0	101.5	168.6	110.0	—	109.4	—
1908	81.8	99.7	141.8	109.5	—	104.9	—
1909	93.1	109.2	141.9	107.2	120.6	90.1	—
1910	104.1	101.2	92.0	127.8	126.2	88.7	—
1911	73.5	91.4	33.5	70.8	119.6	113.8	—
1912	127.0	108.0	29.6	55.4	91.1	97.1	—
1913	61.0	69.5	84.8	83.7	77.0	99.8	—
1914	95.0	86.9	95.3	113.7	97.4	78.0	—
1915	131.9	136.0	200.8	142.7	101.0	102.1	—
1916	70.4	118.5	132.3	92.3	54.0	116.2	—
1917	116.9	118.8	63.3	72.6	88.2	104.8	—
1918	74.4	76.5	32.6	72.6	79.9	64.0	—
1919	110.0	74.5	66.7	93.8	98.8	118.5	—
1920	128.1	109.8	118.8	120.9	93.5	73.6	—
1921	111.3	85.0	64.1	97.0	157.3	92.6	—
1922	110.5	100.9	125.6	102.6	95.6	84.0	—
1923	116.6	117.5	142.8	89.0	64.6	63.7	—
1924	95.1	132.2	129.0	128.1	80.3	92.8	76.0
1925	109.5	83.2	60.3	99.8	155.2	153.4	103.4
1926	78.4	99.6	15.6	88.6	92.8	136.4	126.5
1927	107.9	109.8	137.4	84.4	83.1	122.6	102.0
1928	109.1	114.7	174.1	122.6	113.4	104.5	98.0
1929	87.2	116.5	83.9	93.5	114.2	107.3	107.3
1930	54.3	110.4	133.0	155.9	83.4	77.5	86.5
1931	110.4	93.0	47.4	112.6	93.7	96.4	86.0
1932	110.0	119.3	121.0	102.8	127.7	83.7	112.9
1933	88.8	68.3	61.0	60.5	101.6	93.5	85.0
1934	70.2	32.4	25.4	54.2	83.9	84.4	117.1
1935	104.6	114.2	110.5	78.1	97.7	94.3	110.3
1936	52.2	73.9	—	84.9	113.6	85.2	84.2
1937	121.0	120.6	66.0	67.1	82.3	103.0	100.0
1938	112.2	85.6	64.4	114.2	128.0	111.5	100.3
1939	98.3	85.9	167.5	99.0	92.4	97.6	99.8
1940	84.3	84.8	65.2	74.2	83.9	96.8	91.7
1941	113.9	102.2	88.7	102.3	123.4	109.4	93.1
1942	106.1	110.0	149.7	130.0	105.7	103.9	101.6
1943	105.6	110.3	93.2	100.0	90.3	98.2	98.0
1944	97.7	78.2	90.6	114.9	113.5	99.9	104.1
1945	101.4	125.4	140.6	107.8	95.1	99.5	101.1
1946	104.2	103.6	105.5	101.1	91.0	91.1	106.3
1947	67.1	130.4	144.3	127.0	59.2	101.5	94.1
1948	120.7	121.1	126.2	133.6	116.0	111.3	105.9
1949	103.6	75.4	75.8	65.8	113.9	101.1	98.1
1950	106.9	90.0	120.2	110.9	93.7	86.5	101.6
1951	95.8	86.2	146.2	116.7	108.5	87.9	95.1
1952	100.9	82.8	81.6	99.3	101.7	88.5	100.0
1953	83.9	87.3	55.7	81.9	82.5	117.9	102.2
1954	104.8	—	—	—	96.0	97.8	101.2
1955	110.4	—	—	—	81.0	129.0	97.9
1956	119.4	—	—	—	125.9	87.8	—
1957	—	—	—	—	110.8	—	—

TABLE 2. INDEXES OF THE INFLUENCE OF WEATHER ON VARIOUS AGGREGATE MEASURES OF AGRICULTURAL PRODUCTION AND YIELD, U.S., 1900–1957

Year	Index of Crop Production		Index of Gross Farm Production	Index of Farm Output		Index of Farm Marketings and Home Consumption		Index of Crop Yields Per Harvested Acre	
	Total Index	Feed Grain Component		Total Index	Feed Grain Component	Total Index	Feed Grain Component	Total Index	Feed Grain Component
1900	132.5	102.0	127.9	128.4	102.5	150.0	100.3	131.7	102.0
1901	86.0	27.5	88.0	87.7	27.4	121.2	27.8	83.1	27.5
1902	140.7	167.6	135.6	136.1	167.3	125.1	168.6	141.7	167.6
1903	118.7	104.0	116.4	116.7	104.0	126.0	104.0	118.3	104.0
1904	85.6	78.8	88.4	88.1	78.7	90.4	78.9	84.3	78.8
1905	107.1	127.4	107.4	107.4	127.4	96.1	127.6	106.7	127.4
1906	99.0	105.9	99.5	99.4	105.9	95.2	105.9	98.8	105.9
1907	112.7	115.2	110.6	110.8	115.6	108.6	119.2	161.3	115.1
1908	97.1	88.5	98.4	98.3	89.1	103.1	92.2	139.4	88.5
1909	99.8	98.8	99.7	99.7	99.3	100.8	101.8	100.0	98.8
1910	106.4	102.9	104.7	104.9	102.8	107.6	102.1	106.9	102.9
1911	84.1	74.1	84.2	84.3	73.9	89.3	71.0	83.1	74.2
1912	98.2	117.8	98.6	98.6	117.0	86.5	111.6	98.2	117.9
1913	76.7	63.9	79.1	78.9	64.1	84.3	65.3	75.8	63.9
1914	94.9	93.6	95.1	95.1	93.6	95.1	93.8	95.3	93.6
1915	128.9	136.8	127.7	127.8	137.4	125.3	141.4	129.6	136.7
1916	90.6	82.4	93.1	92.8	83.1	96.2	85.5	89.7	82.4
1917	101.6	114.0	101.7	101.7	113.5	94.4	110.3	101.5	114.0
1918	70.9	72.2	74.8	74.4	71.9	69.3	69.3	71.0	72.3
1919	103.2	101.3	104.6	104.5	100.8	104.1	99.2	102.6	101.3
1920	111.2	124.4	96.3	111.2	124.3	103.3	124.2	112.3	124.4
1921	102.4	103.9	103.3	103.2	103 4	100.8	101.3	102.6	103.9
1922	101.9	109.8	102.8	102.7	109.9	97.7	111.0	102.4	109.7
1923	97.5	118.4	98.6	98.5	118.6	86.2	120.1	98.5	118.3
1924	103.4	103.5	103.6	103.5	103.9	103.0	105.0	103.7	103.6
1925	114.3	102.0	111.7	112.0	101.5	120.1	99.3	113.1	102.0
1926	96.2	78.2	96.5	96.4	77.8	104.8	73.4	95.0	78.3
1927	105.5	110.0	106.2	106.1	110.3	104.2	112.0	105.0	110.0
1928	112.7	114.0	111.4	111.6	114.6	112.6	118.3	112.8	114.0
1929	97.5	92.0	98.1	98.0	92.1	100.2	91.1	97.2	92.1
1930	82.1	68.7	82.3	82.3	69.5	89.1	72.8	82.2	68.7
1931	102.3	103.6	100.7	100.8	103.0	100.5	99.7	102.5	103.6
1932	105.3	112.3	103.8	104.0	110.4	101.9	112.8	106.0	112.3
1933	81.7	83.6	82.1	82.0	83.3	80.9	82.2	81.4	83.6
1934	69.4	61.0	69.1	69.1	60.5	73.8	58.8	69.0	61.0
1935	98.2	106.6	98.2	98.9	106.7	94.4	106.8	98.3	106.6
1936	73.0	56.2	72.8	72.8	56.3	81.0	55.9	70.4	56.2
1937	101.5	117.6	100.3	100.4	117.1	93.3	113.8	101.5	117.6
1938	108.7	104.7	108.2	108.2	104.2	110.0	102.1	108.7	104.7
1939	99.1	100.4	98.0	98.1	100.9	99.6	105.4	99.1	100.3
1940	84.7	83.2	86.2	86.1	83.1	85.5	51.9	84.4	83.2
1941	107.8	110.4	107.0	107.1	110.1	106.2	108.9	107.8	110.4
1942	111.8	109.4	111.8	111.8	109.8	113.2	112.3	112.0	109.4
1943	101.8	105.7	101.8	101.7	105.6	99.6	104.7	101.9	105.7
1944	101.0	93.9	101.1	101.0	93.8	104.3	93.9	101.1	93.9
1945	105.1	107.9	105.8	106.8	108.3	104.1	110.0	105.3	107.9
1946	100.5	104.2	100.9	100.8	104.2	98.7	104.3	100.8	104.2
1947	95.3	82.7	96.7	96.5	83.5	102.1	86.4	95.1	82.7
1948	120.4	121.1	118.2	118.4	121.1	119.7	121.5	120.6	121.1
1949	92.3	97.1	94.1	93.9	96.7	90.1	95.8	92.0	97.1
1950	101.7	104.8	102.4	102.3	104.9	100.1	106.1	102.1	104.8
1951	99.7	97.2	100.6	100.5	97.6	101.2	100.9	100.0	97.2
1952	96.0	96.6	96.2	96.2	96.4	89.1	95.7	96.2	96.6
1953	91.0	82.8	91.2	91.2	82.5	95.2	80.8	90.3	82.8
1954	90.1	104.8	90.2	90.2	104.8	84.9	104.8	90.0	104.8
1955	107.3	110.4	105.8	105.9	110.4	106.6	110.4	106.7	110.4
1956	107.5	119.4	107.5	107.6	119.4	101.7	119.4	108.2	119.4
1957	110.8	—	110.8	110.8	—	110.8	—	110.8	—

TABLE 3. ESTIMATED PARAMETERS FOR THE REGRESSION OF THE RESIDUALS ABOUT AN ELEVEN-YEAR MOVING AVERAGE OF SPECIFIED U.S. AVERAGE YIELDS AND OF AGGREGATE INDEXES ON THE CORRESPONDING COMPUTED WEATHER INDEXES[1]

Series	a	b	R^2
U.S. Average Yields			
Corn (bu./A.)	− 11.93	.12**	.6146
Oats (bu./A.)	− 11.46	.11**	.3780
Barley (bu./A.)	− 2.48	.02**	.2148
Wheat (bu./A.)	− 2.66	.03**	.2215
Soybeans (bu./A.)	− 4.12	.04**	.1781
Cotton (lb./A.)	− 36.60	.36**	.0825
Tobacco (lb./A.)	−131.20	1.27*	.1110
Production Measures			
Index of Crop Production			
All crops	− 28.13	.28**	.4351
Feed grains	− 42.31	.43**	.6133
Index of Gross Farm Production			
All Commodities	− 20.63	.21**	.4372
Index of Farm Output			
All Commodities	− 21.35	.21**	.4036
Index of Farm Marketings and Home Consumption			
All Commodities	− 2.99	.03	.0184
Feed Grains	1.48	.01	.0003
Production Per Unit			
Index of Crop Production per Harvested Acre	− 34.39	.35**	.6811

[1] a and b are computed for the regression discussed in "Evaluation of the Indexes," above. R^2 is the "coefficient of determination." A "one-tail" test was made of the hypotheses $b=0$ for each b. The b's significantly different from 0 at the 1- and 5-percent levels of significance are marked ** and * respectively. Those not marked were not significant at these levels.

5. Indexes for the seven crops were weighted together into indexes of the influence of weather on various aggregate measures of production and yields using value of production during the chosen base period 1947-49. The indexes of Range Conditions as presented in various USDA publications were also combined into an index and used where applicable.

The computed indexes are presented in Tables 1 and 2. It was assumed that computation of the indexes back to 1900 would be sufficient for most uses. Also, data became increasingly scarce as the length of the period increased.

Evaluation of the Indexes

In evaluating the various indexes, special emphasis was given to determining their reliability and usefulness in estimating structural parameters in various econometric studies. An indication of the reliability and usefulness of each was obtained by computing a regression of deviations about an 11-year moving average of the U. S. average yield for the commodity on

the corresponding computed weather index. Similar regressions were computed for the several aggregate indexes. This regression was chosen because it was decided that it was reasonable considering the probable uses of the weather indexes. Deviations about an 11-year moving average were used in an attempt to hold technological change constant. The parameters of this regression are presented in Table 3.

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Land Reform and Democracy, Clarence Senior. Gainesville, Florida: University of Florida Press, 1958. Pp. xiii, 266 plus index. $6.75.

This is a study of the transformations made in one of the best commercial farming regions in Mexico by the land reform revolution. The author has been a close observer of this region, the Laguna, almost from the beginning of the program in 1936—initially as an associate of the American Friends Service Committee. As he has watched the ups and downs of this experiment, he evidently resolved to study it intensively as a possible object lesson of significance to the "world-wide revolution in our times" in land reform. The result is this monograph which tells the story of land reform and its consequences in the Laguna district, set in the larger context of the Mexican Revolution of 1911 and its aftermath, but interpreted in terms of world-wide issues in land reform.

Dr. Senior's deepest interest is in the progress toward democracy by a peasantry habituated to centuries of serfdom. "I set out to follow the Laguna experiment in the hope of learning first hand how democracy grows after feudalism is destroyed." (P. vi.) Also, "the purpose of this study is to lay the basis for an understanding of the principal problems of agrarianism, insofar as its advocates hope to build a new social system in which democratic values and practices are basic . . . to contribute something to discussions of policy and to the forging of agrarian methods consonant with democracy." (P. 12.)

The account of the Mexican Revolution is sketchy, necessarily, but there are helpful citations to the more inclusive histories. It is of considerable importance that the revolution came to the Laguna district in 1936, 25 years after the start of the revolution, and almost 20 years after the subsidence of the civil war. Laguna is a centrally located cotton growing region, in which commercial farming took early root, partly with foreign capital—resulting in what the author calls capitalistic feudalism. "It partook of the nature of feudalism as a type, insofar as the entire social relationship revolved around land-ownership and the power which such ownership gave over the welfare and even the lives of the landless landworkers. It assumed a capitalistic character in that production was for the market and that the 'cash nexus,' instead of fealty to the lord, bound men together." (P. 56.)

Since the major revolt in the Mexican Revolution was against the latifundia, the Laguna region evidently serves well as representing the critical issues. Similar situations of this kind of "capitalist feudalism" are found over much of Latin America, and indeed in all underdeveloped areas where large land holdings occur amidst poverty and over-population.

From the adoption of the constitution in 1917 until the decree of October 1936, specifically directed to the Laguna region, tension and conflict had mounted. President Cardenas had been elected in 1934 in a campaign in which he urged the plain "people to do something for themselves." Being sympathetic to the peasants, he gave personal attention to the problems of reconstruction in the Laguna district. His administration both enforced the decrees expropriating land (about three fourths of the irrigated land, p. 66) and worked diligently to help create the necessary new institutions to carry the reform forward. The author considers the struggle which culminated in the expropriation of land as an example of "how peasants . . . achieve . . . power to carry out land reform." (P. 66.) A substantial part of this achievement of power would seem to be integral to their achieving a significant political citizenship, particularly under a sympathetic President.

The major institution for distributing land to the peasants in Mexico was the ejido, as is well known. This monograph provides a quite detailed account regarding the genesis of the ejidos in this region. Although the ejidos are peculiarly rooted in the Aztec and Spanish antecedents of Mexican culture, certain aspects of this experience are of general significance. Persons are members of the ejido, and the ejido owns the land. Individuals share in the land allotments on a use basis. Members "can not sell, lease, rent, mortgage, alienate the land in any way." (P. 94.) The land in the ejidos was taken from the large holdings under a provision whereby the owner could keep a minimum of 150 hectares (375 acres) of land selected as he chose from his total land holdings and water supply. The basic idea of the ejido was originally that of a subsistence holding supplementary to employment on the hacienda. An attempt was made to allot four hectares of land to each peasant family. Among the complications in the Laguna region was a heavy in-migration of people into the area as laborers in anticipation of land distribution. They were included as sharers of allotments, thus loading up the ejidos beyond capacity. It is small wonder that the yields on the ejidos are evidently below the yields on private lands; and that many of the on-coming generation can not find a place in parent ejidos.

The responsibility for getting the ejidos organized and in operation was placed upon the National Banco Ejidal—through a "supervised credit" program extended only to the cooperatives, which was originally supervision and guidance of the most comprehensive sort.

There is no need here to attempt a full summary of the author's quite detailed account of the emerging democracy—treated under the titles, "Framework of Agrarian Democracy" and "Problems and Progress in Building an Agrarian Democracy."

Many parallels can be found in experiences in other countries of the

problems encountered in Mexico. The Development Bank of Iran is very similar in purpose and proposed function to the Banco Ejidal. In both instances the "Bank" is much more than a bank in the usual sense of the term. But in scope of operations both fall far short of the program of land reform administration in Egypt, for example.

The ejido is a village cooperative undertaking. All attempts at cooperative farming based upon membership in the cooperative without individual ownership of the land by the cooperators must, if they are to be democratic, work out a set of procedural rules which provide for the individual participants approximately the kind of security of expectations which individuals have with private ownership of land and direct market access. Although not discussed precisely in these terms, it is the study of the procedures and institutions which have been devised to create a dependable economic citizenship in the ejido which is at the very heart of this interpretation. It is one of the great merits of Dr. Senior's work that he has noted the activities in such detail—as the determination of eligibility for land, the vigilance committees in the ejido, the experiments with alternative incentive methods for compensation to participants, etc.—that it will be possible to make comparisons with other land reform programs in other countries and cultures.

The basic, or at least the avowed, orientation of the analysis is toward sociological issues. He makes use of Merton's thesis of "strain, tension, contradictions and discrepancy" in revolutionary situations as a stage for the analysis. He closes his inquiry by reference to Lasswell's eight "goal values of democracy" in the concluding chapter, "Democracy Comes to the Cotton Kingdom."

The basic data in the study are both comprehensive and fragmentary. The author has drawn on many sources for information, ranged over a span of years. Factually the study lacks the kind of coordinate analysis of interrelationships which comprehensive tabulations from survey schedules might provide. But this is of minor significance, since it is the interpretations of the author based upon close and devoted association with the region over a span of 15 years which provide the basic structure of the report. In the meantime, Dr. Senior has worked in several assignments, including his present position as Chief of the Migration Division, Department of Labor, Puerto Rico. Since the author is as concerned to note the failures as he is the successes in Laguna, one gets to see a good bit of the seamy side of the land reform experiment. It is a workmanlike report that deserves reflective reading, and is worthy of widespread emulation.

KENNETH H. PARSONS

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The Brannan Plan: Farm Politics and Policy, Reo M. Christenson. Ann Arbor, Michigan: University of Michigan Press, 1959. Pp. 207, $5.00.

Members of this association are generally familiar with the background, the formulation, and the controversy generated by the income support statement by Secretary of Agriculture Charles F. Brannan, April 7, 1949. The Brannan statement, made at a joint hearing of the House Committee on Agriculture and the Senate Committee on Agriculture and Forestry, is one of the many important events in the history of Agricultural Policy. This is true in several respects. The "Brannan Plan" was the first fully ordered attempt to make operational, by means of "income supports," the expressed desire to improve the aggregate level of farm income. In this respect the Brannan Plan was not without precedent. Direct payments, in principle, had been used in the AAA program, for sugar production, and for incentive adjustment to war production goals. Those familiar with the detail of agricultural policy legislation are well aware of the statutory definition of parity income in the 1936, 1938, and 1948 Acts. The Brannan Plan differed from earlier legislative proposals in the development of an "income standard" as a method of computing price-support levels for farm products. As a matter of emphasis certain distinctions can also be drawn between the primary objectives of "income parity" and an income support standard. Brannan apparently held the belief that agriculture played a superior role in economic progress and that, consequently, the maintenance of farm income at a high level was a means of stabilizing the economy as a whole.

One merit of Dr. Christenson's study is that it lifts much of the mystery with respect to how the Brannan Plan was formulated and with respect to what was really at issue in the politics of the matter. From factual detail the author has fashioned a firm but fair statement of politics and policy formation insofar as the Brannan Plan is concerned. It would, therefore, seem to follow that his treatment of the subject constitutes an addition to the theories on political behavior. It is also evident that the author is more than a little convinced that the direct-payment, free-market system has more of a future than a past on the American farm legislative scene. In support of this argument he offers in evidence allied material which indicates that there is general agreement among Agricultural Economists and others that such income supports as are undertaken should be in the form of direct payments to producers rather than by means of manipulation of market prices.

But it cannot be concluded that this study is primarily premised on a plea for a special type of price (income) support program. The material stands as a contribution to the body of knowledge regarding the political processes by which the broad outline of agricultural policy is laid out.

And while this identity will probably remain necessarily true, the author points out in Chapter V, "Observations," that perhaps better "policies" would be forthcoming if other institutional bodies, the USDA particularly, were allowed to play a more active role.

The "Brannan Plan"—properly stated, an appraisal of the economics and political implications—is set forth in five main chapters plus twenty pages of footnotes which in themselves add additional interpretation. If this set were subjected to a further reordering the segments of the book would fall into these categories: (1) a statement of the basis for farm income support, (2) the mechanics (means) by which this objective can be reached, and (3) the confounding (at times) contribution of politics.

Starting with Chapter I, in which the Brannan Plan is immediately identified, the purpose is to trace out what had happened in the area of price-income policy and how the thinking of the time influenced or guided the events leading up to the April 7, 1949 statement. The scene is set, so to speak, from which to point out and highlight the circumstances and fracturing of relations that apparently touched off the controversy over a program which, under more normal conditions, might have been looked upon for what it was—a proposed course of action. A number of things were against Brannan's proposal right from the start, not the least of which were several structural elements which reflected on the internal consistency of the proposal. These were sufficient to bring on controversy even if the shadow of politics had not been involved. That politics is involved is obvious right from the start and the plan thus was doomed before a point of compromise could be reached. Readers will find Chapters I, II, and III to be a particularly informative coverage of the background and formulative procedures.

The question might well be asked, and Dr. Christenson raises this question, if income is the objective and direct payments are an acceptable means, why is it thus that direct income supports have not been used in any complete sense. The answer, at least in part, lies in the realm of how to make them both acceptable and workable. The author would not deny, I am sure, that workability is a necessary adjunct to acceptance. This is not to say that some form of parity income or an income support standard cannot be made workable. The inter-play of acceptance and workability, however, must be kept foremost in mind.

The case is summed up in Chapter IV, "Brannan's Plan: Down But Not Out." In this chapter, the author points out what he considers to be the most appealing aspects of the Plan, evaluates the factors which accounted for the failure of the Plan to be accepted and sets down his conclusions about the probable indirect influences the Plan had on later legislation. Chapter IV is concluded with this observation, "The possible advantages to the consumer, the farmer, and the harassed USDA under some varia-

tion of the Brannan Plan formula are simply too great for the nation to ignore any longer. Compared to the inexcusable distress which the free market would bring, and the endless complication, contradictions, and over-all costs of the price support system, a modified Brannan Plan would fairly reek of common sense."

Whether one agrees or disagrees, this view is one side of the many-sided spectrum through which we must view and analyze public policy.

DOUGLAS D. CATON

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The Competitive Potential of the U. S. Cotton Industry, Clifton B. Cox and Vernon W. Pherson, Boston: Harvard University, Graduate School of Business Administration, Division of Research, 1959. Pp. xx, 201. $3.00.

This book represents the latest addition to a large and growing literature on various facets of the "cotton problem." To assess *The Competitive Potential of the U. S. Cotton Industry* is a formidable undertaking indeed. Yet this is the task which Professors Cox and Pherson have undertaken in this volume. More specifically, ". . . the basic objective of this study is to determine the future competitive position of the U. S. cotton industry in both the domestic and foreign markets" (page 3). Research underlying the book was conducted under the auspices of the Program in Agriculture and Business at the Graduate School of Business Administration, Harvard University. Most of the information upon which the analysis is based is drawn from published and unpublished studies conducted by the National Cotton Council of America and the U. S. Department of Agriculture.

The authors consider five factors to be the most important determinants of the competitive position of the U. S. cotton industry. They are (1) per capita real income, (2) price, (3) quality, (4) promotion, and (5) trade arrangements. Each of these factors is analyzed separately in chapters IV through VIII, respectively. In the final chapter the authors propose a plan of action for the industry to improve its competitive position, and advance some tentative quantitative estimates of the probable effects if the plans are carried out.

The major findings may be summarized as follows:

1. The per capita demand for textiles in general can be expected to expand in about the same proportion as real per capita incomes. Thus the demand for cotton will depend primarily on inter-fiber competition (page 47).
2. Inter-fiber competition in total end-use markets does not depend on one factor alone, but on a combination of price, quality, and promotion (page 36).

3. "Trade arrangements do affect the future of cotton. . . ." (page 138), the effect of the arrangements depending upon the terms of the agreement. This conclusion is hardly unexpected since the authors define trade arrangements to ". . . include any marketing agreements or arrangements that affect the movement of products differently from that in a relatively free market. . . ." (page 33).

Based on their analysis, the authors propose the following courses of action: (1) price competitively, (2) produce raw cotton comparable in quality with foreign-grown cotton and to a certain extent with man-made fibers, (3) produce end-use products with desired qualities, (4) expand promotional activities, and (5) seek a favorable environment for the growth of the industry through legislation and governmental policies. To provide information needed in the implementation of these proposals, an expanded research program requiring an investment of an additional twelve to fifteen million dollars annually is also proposed, including more research on import-export policy.

Depending upon the extent to which these proposals are carried out, the authors conclude that ". . . the future of the U. S. cotton industry probably lies somewhere between a net loss averaging 500,000 bales per year and an increase averaging about 750,000 bales per year for the next decade at least. . . ." (page 150). While it is not clear to this reviewer how these estimates were obtained, I expect that the interval is wide enough to contain the actual outcome.

Clearly, the loss of markets for U. S. cotton is one of the most pressing politico-economic problems confronting any domestic agricultural industry today. It is also one of the most controversial. The causes of and feasible solutions to the problem have been the subject of widespread interest and concern at least since the early 1930's. For agricultural economists, this book adds little that is new either in methodology, in hypothetical or empirical relationships, or in recommendations. At the risk of underrating the contribution of Professors Cox and Pherson, this reviewer would characterize this book as primarily a straightforward recapitulation of the results of studies conducted by the National Cotton Council.

Analyically, this reviewer is most impressed with the acceptance of differential supply elasticities in foreign countries and "trade arrangements" as major determinants of market results in the export market. It is regrettable that the analysis of trade arrangements was not extended to a more general consideration of the fundamental structural changes which are so clearly evident in the export market sector of the world's cotton economy. In addition, the analysis would have been strengthened materially if the concepts of differential supply elasticities and trade arrangements (including basic structural changes in the export market) had been

incorporated within a unified analytical framework. This would have made clear not only their causal role as export demand determinants, but also their interrelationships.

In spite of these limitations, however, Cox and Pherson have made a valuable contribution. The results of numerous studies, many unpublished, are synthesized and made available in a single volume. The book is perhaps the most comprehensive study yet published dealing specifically with the competitive characteristics of the markets for cotton. It represents a well-balanced view of past and present, and takes a very cautious peek into the future.

The analysis has some other strong points. It is a welcome antidote to much of the "bogey man" thinking concerning the relation between price support policy and the loss of cotton markets. The loss of markets has, of course, been attributed to many factors; most analysts, however, have placed the blame primarily on domestic price and production control policy. The obvious solution which follows from this diagnosis is to permit cotton prices to seek their competitive level as determined by the free play of economic forces. Professors Cox and Pherson, however, do not view a return to an unrestricted price system as a panacea for the problems confronting the cotton industry. In this regard they have shown a much greater respect for realism than most contemporary writers on the cotton problem.

This is not to say that the authors do not consider price to be an important factor in cotton's struggle for markets. They do. What they have done is to place price in its proper position coordinate with other important factors affecting the competitive position of any product whose markets are characterized by conditions of imperfect competition. There is little ammunition in this book for either adversary in the continuing controversy over price policy.

MARK L. FOWLER

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Economic Surveys in Under-Developed Countries—A Study in Methodology, P. K. Mukherjee. New York: Asia Publishing House, 1959. Pp. 16, 263. $5.60.

Professor Mukherjee is head of the Agricultural Economics Section of the School of Economics, University of Delhi, where he teaches agricultural economics and applied statistics. He is a graduate of Calcutta and Oxford Universities, and has had extensive research experience including a period of time spent at the Indian Statistical Institute at Calcutta.

This book is concerned with the methodology of executing research

studies requiring the use of statistical surveys "to determine economic conditions and economic relations" of self-sufficient regional rural communities in underdeveloped countries such as India. The discussion is focused mainly on the problem of measuring the flow of income and the transactions of the rural economy within a region and with the rest of the economy and the world. The aim is to portray an economic model which will permit the framing of suitable hypotheses, and the careful definition of concepts into terms that are measurable.

In view of the general weakness of research methodology in studies of the economics of agriculture in the Subcontinent, not to mention similar failings elsewhere, this book is concerned with a worthwhile objective indeed. But it should be clear that this is not a book on applied economics research methodology. It might have made a greater contribution had there been more stress on the principles of good research methodology, emphasizing especially the importance of using well-founded hypotheses as the first step in solving a research problem.

The book consists of three parts. Part One—Historical and Descriptive—describes the characteristics of a typical Indian village and reviews the rural economic surveys of the past. Part Two—Economic Concepts and Their Measurability—discusses various concepts and seeks to define them in measurable terms in seven chapters dealing with the conditions of a closed and vulnerable economy, subsistence and low income farming, unemployment in a self-sufficient economy, farm wages, rural income, farm costs, prices and marketing. Part Three, entitled "Practical Aspects of Statistical Measurement," consists of two chapters directly concerned with survey technique including the design and execution of "sample" surveys and with methods of analysis.

It will be apparent from this brief outline that most of the space is spent on concepts and their measurability in the long second part of the book. Admittedly much of this material helps to explain the economic model of the rural economy the author wishes to get across, but it could have been shortened materially. In general the book is difficult to read and the fact that it is unduly wordy, and loaded with quotations, obscures the clear statement of principles and conclusions. There is a tendency to appeal to authority rather than to present a viewpoint that has been thought through or which is generally accepted. Still, the book is wide-ranging in its treatment of economic phenomena and concepts and frequently presents keen insights that should be very useful to the researcher. The general viewpoint it presents of the rural economy in a broad economic and social setting is a major contribution and should assist in the formulation of improved research hypotheses.

The book has a number of weaknesses, of which the major one in the opinion of this reviewer is in the presentation of the statistical aspects of the survey problem. In a book on sample survey technique some solid

discussion might have been expected of alternative methods of sampling and of the case study approach, especially when writing for an audience that may need more guidance in this matter than perhaps in other aspects of survey research. It might have been useful also to present data relating the cost of surveys to sample size, sampling procedures, and statistical accuracy.

The sparse treatment of sampling procedure is particularly nonrigorous and unmistakably vague. It is argued that since the object is not to make "over-all estimates for the population . . . there is no absolute need for the test material to be selected at random. . . ." The author then proposes a purposive stratification based on "a method of 'representative' (sic) selection, as developed by Kiaer (1895)" (sic) (p. 199). This is indicated as preferable over a random sample of villages which "would be neither necessary nor feasible" (p. 200). It is suggested that total "flow estimates" can be made by combining the data procured in this way with trade, production, expenditure, and income data derived by other means. The useful idea is proposed of arranging the data according to the Leontief input-output table.

A major failing is that the references to research concepts and methodology in the field of agricultural economics are mostly very old, particularly in the case of American authors. (Some of this may be excused in some degree in light of the difficulty of obtaining books from abroad.) For example, there are no references to the work of John D. Black later than the 1933 Social Science Research Council methodological studies edited by him. In fact most of Appendix I on the problem of Evaluation of Non-Monetary Income and Out-Goings in a Farm Family Enterprise is based on a discussion of concepts proposed by Black in these studies and by C. C. Zimmerman in a 1927 *JFE* article. For some unaccountable reason there is no reference to John D. Black's comprehensive outline of proposed agricultural economics research projects and methodology prepared about 1955-56, based on Indian conditions.

Another example of dated techniques is shown in the classification of the methods of collecting data according to the questionnaire, recording or account, and schedule methods. The questionnaire method is interpreted in the narrow sense of a mail questionnaire. The entire classification is reminiscent of the early history of farm management research in the United States as used in the Twenties.

In spite of such deficiencies Dr. Mukherjee has written a book which presents many stimulating ideas. It is true that not all can be accepted without questioning, but they should have the effect of pushing trains of thought along fruitful lines of endeavor, and hopefully with a greater respect for improved methods of research.

WILLIAM BREDO

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Foreign Trade and Finance, W. R. Allen and C. L. Allen (Eds.). Macmillan, 1959. Pp. xii, 500. $6.00

This is more than just another book of readings in the theory of interregional and international trade. It is a rarity among readings; it makes a contribution, and should be very useful to students of the subject. Fortunately for the reviewer, he was familiar with most of the articles included in the volume and with the viewpoints of the writers represented.

Three characteristics distinguish this effort from many others of the same nature. First, the editors have succeeded to a high degree in achieving homogeneity of the various items. Five sections include twenty-three articles from eighteen writers, most of whom are big names in the field of foreign trade analysis. Theory and policy issues, balance of payments problems, the international adjustment process, the exchange rate argument and the case for multilateralism are covered by articles so carefully selected that within and between groupings the reader's attention is unhampered as he proceeds to study the questions at issue.

Second, and definitely a positive attribute, is the coordinating treatment afforded the articles within sections. An introduction precedes each section, in which issues are pointed up in the manner one would expect to find in a one-author text on the subject. The groups of articles are then permitted to speak for themselves, after which a commentary clears the air and resolves the difficulties which were raised by the various articles. No little time was required for this treatment, and it is tempting to refer to the Allens as "authors" of a book.

A third distinguishing feature of this book is a matter too often overlooked in the choosing of readings; I refer to the tendency to include everything and everybody lest something and somebody should be overlooked. The result is many times a catch-all or hodge-podge of uncoordinated articles some of which, though individually outstanding, have little academic or classroom utility. Not so with this book. There is not an inferior inclusion. And, even though such name writers as Condliffe, Ellsworth, and Kindleberger are not included, one could scarcely say that the book has suffered greatly.

It is not a book for beginners. Though not explicitly stated in the *Foreword,* one assumes that the editors would agree that its greatest utility would lie in fields beyond first-year economics, and after students have been exposed to elementary trade theory. It could be used as a text for a second semester of international trade, as a limited supplement to the first course on the same subject, and as a specific point of take-off for a graduate seminar in international trade and finance. In addition, confirmed students of the subject, in which the reviewer places himself, will welcome this volume as a reference to which they can go for recent treat-

ments of a subject which was responsible for our professional beginnings.

Only one of the twenty-three selections was written prior to the end of World War II: that of Folke Hilgert's classic, "The Case for Multilateral Trade," which appeared in the *AER Supplement*, Vol. XXXIII (March, 1943). Hence, we find a distinct postwar flavor in a large portion of the volume. The theme of this period has, of course, emphasized equilibrium and adjustment between and within countries, but particularly the latter. The fact that financial aspects of the trade process are dominant in this book attests to post-World War II attempts to reconstruct a workable monetary equilibrating mechanism out of a chaos, the seeds of which were sown prior to the first World War. That such a collection could not possibly include all topics which impinge on this question is readily understandable. A few more articles on the structural causes of the fundamental disequilibrium which we have experienced would have, of necessity, emphasized the international economic harmony of the classical era. This by its very nostalgic effects would have pleased some potential purchasers! The reviewer's personal desire is that a treatment of the very recent turn of events in international exchange restrictions and balances could have been included, but the date of publication forbade such. I speak of the current balance-of-payments position of the United States vis-a-vis Free Europe.

In deference to those who would have a reviewer "commit" himself on some particular selection(s), I should like to do two things. First, I should vote the Senior Editor's article, "International Trade Theory, Commercial Policy and the Economist," *Political Science Quarterly*, Vol. LXIII (March, 1958)—pp. 13-21 in the book under review—as being notably worthy of mention. Second, I should like to place my vote firmly with Nurkse and others as opposed to Friedman in the argument over freely fluctuating exchange rates. Possibly Friedman, who advocates fluctuating rates, just didn't understand the true nature of the international disequilibrium when he, in 1950, wrote, "Whatever may have been the merits of this [IMF pegged exchange rates] system for another day, it is ill-suited to current economic and political conditions." (See p. 313).

We may well conclude on this point: Friedman intimates that it is the "traditionalists" and the "reformers" who distrust flexible rates. To which we would reply: Who is more traditional than a micro-staticist in the 20th Century, and who would reform more than those who would turn the clock "ahead" only to turn it back by making conditions of production and distribution conform to unrealistic theoretical norms? Don't the terms *free trade, free competition,* and *flexibility* sound a little hollow in a world of Amtorg, Public Law 480, and the like?

JIMMYE S. HILLMAN

University of Arizona

NEWS NOTES

GERALD E. ACKERMAN, who recently completed the requirements for the Ph.D. degree at Purdue University, has accepted a position with the Provincial Extension Service of the Province of Alberta. He is located at Edmonton.

WILLIAM W. ADDISON has joined the staff of the Farm Economics Research Division, Agricultural Research Service, USDA, where he will work on production needs and response. He was formerly with the Statistical and Historical Research Branch of the Agricultural Marketing Service.

GEORGE ALLEN, who recently received the M.S. degree at the University of West Virginia, has joined the Washington staff of the Marketing Economics Research Division, Agricultural Marketing Service, USDA.

C. B. BAKER, University of Illinois, was the J. S. McLean Visiting Professor in the Department of Agricultural Economics, Ontario Agricultural College, in early February.

RANDOLPH BARKER is carrying on cooperative research with the Department of Agricultural Economics at Cornell in his position as Agricultural Economist, Farm Economics Research Division, Agricultural Research Service, USDA.

GEORGE W. BARR, Economic Consultant for the Food and Agriculture Organization, UN, to the Banco do Nordeste do Brasil, is in the United States for three months leave before returning to Fortaleza, Brazil about February 1.

ROBERT BEVINS has accepted a two year assignment at Michigan State University to an extension position on public policy, effective January 1. He will serve in this position while Gar Wood is in Colombia.

BOND BIBLE, Rural Sociologist from Pennsylvania State University, has been appointed Extension Rural Sociologist at Ohio State University.

RUSSELL BIERMAN, formerly with the Farm Economics Research Division, Agricultural Research Service, USDA, reached his new ICA post as Chief, Agricultural Economics Branch, Agricultural Division, USOM, in Seoul, Korea, in September.

H. WAYNE BITTING transferred in October from the Marketing Economics Research Division, Agricultural Marketing Service, to the Agricultural Research Service, USDA.

UEL BLANK returned November 1 from graduate study at Michigan State to be Extension Economist (Marketing), University of Missouri.

B. J. BOND, Washington State University, has completed requirements for the Ph.D. degree at the University of Illinois.

J. CARROLL BOTTUM has returned to Purdue University after serving as Visiting Professor on the staff of the Iowa State University Center for Agricultural Adjustment.

CALVIN C. BOYKIN, JR., was appointed Agricultural Economist with the Farm Economics Research Division, Agricultural Research Service, USDA, stationed at New Mexico State University, effective September 21. He will be engaged in cooperative research problems in ranch and range economics with the Department of Agricultural Economics, New Mexico Agricultural Experiment Station.

WILLIAM BRAITHWAITE has been appointed a Lecturer in the field of business administration in the Department of Agricultural Economics at the Ontario

Agricultural College. Mr. Braithwaite is a graduate in Business Administration from the University of Western Ontario and also holds a Chartered Accountant's degree.

V. JOHN BRENSIKE of the Marketing Economics Research Division, Agricultural Marketing Service, USDA, acted as a technical leader for the Soviet Mixed Feeds Team which visited this country in October under the sponsorship of the State Department's Technical and Cultural Exchange Program. The general objectives of the team were to study the formula feeds industry and animal and poultry nutrition research in the United States.

DAVID CALL, formerly an Instructor at Cornell University, has accepted a position in Marketing Extension at Michigan State University as Assistant Professor of Agricultural Economics. He will join the staff on March 1, 1960.

PROCTOR CAMPBELL, formerly with the Production Development Section of the Market Development Research Division, Agricultural Marketing Service, USDA, transferred to the Defense Department in November.

NEAL R. CARPENTER, Instructor in Farm Management Extension at Ohio State University, has taken a two-year assignment with the India-Ohio project in India.

J. B. CLAAR, Federal Extension Service, has completed the requirements for the Ph.D. degree at the University of Illinois.

HOWARD E. CONKLIN, of Cornell University, is serving in Venezuela from October to January with a research team sponsored by Consejo de Bienestar Rural, Automercado 'Las Mercedes' to study agricultural potentials in parts of that country.

HUGH L. COOK will spend three months in Venezuela beginning in January. He will be sponsored by the Consejo de Bienestar Rural and will consult with the Ministry of Agriculture in planning marketing control, subsidy, and pricing programs to develop the dairy industry.

W. C. CROW was appointed Director of the newly established Transportation and Facilities Research Division, Agricultural Marketing Service, USDA, effective October 9.

CLARENCE E. DAVAN, who recently completed the requirements for the Ph.D. degree at Purdue University, has accepted a position with the Cost, Income and Efficiency Branch, Farm Economics Research Division, Agricultural Research Service, USDA. He will be located at Fort Collins, Colorado.

MICHAEL DORLING, formerly of the British Ministry of Agriculture has accepted a three year appointment for special production research at the Ontario Agricultural College.

M. LLOYD DOWNEN, Agricultural Economist in the Experiment Station, has been promoted to Head of Agricultural Economics Extension Work at the University of Tennessee.

J. NORMAN EFFERSON, Dean of the College of Agriculture at Louisiana State University, has just been reelected to a five year term on the Board of Trustees of the Council on Economic and Cultural Affairs.

F. F. (BUCK) ELLIOTT has moved from Washington to Tucson, Arizona, where his home is at 5322 East Rosewood Avenue. Dr. Elliott, former Associate Chief of the Bureau of Agricultural Economics, retired from USDA in 1954.

ERNEST FEDER, of the University of Nebraska, attended the tenth meeting of the Mexican Society of Sociologists at San Luis Potosi December 7-11. He presented a paper on "The Common Market in Latin America."

B. H. FRAME, Professor of Agricultural Economics, University of Missouri became Professor Emeritus last September 1.

JIM GIGOUX has resigned as Instructor, Department of Agricultural Economics and Rural Sociology, University of Arkansas, to accept a position as Associate Economist with the State Department of Water Resources, Sacramento, California. He will work on economic evaluations of water resource development.

J. C. GILSON, Department of Agricultural Economics and Farm Management, University of Manitoba, was appointed Chairman of the Board of the newly constituted Manitoba Crop Insurance Corporation.

ELCO GREENSHIELDS, Farm Economics Research Division, Agricultural Research Service, USDA, left Washington on December 27 for a two-year assignment with The Food and Agriculture Organization, UN, in Rome. He will be in the Office of the Head, Economics Department, where he will assist and advise in appraising, in both the planning and operational stages, the economic and financial feasibility of resource development projects which FAO is requested to advise upon or to execute.

ALBERT HAGAN returned from graduate study at Michigan State University to assume a post in farm management as Professor of Agricultural Economics, University of Missouri, February 1, 1959.

LOUIS F. HERRMANN, of the Marketing Economics Research Division, Agricultural Marketing Service, USDA, is serving temporarily as a marketing research specialist with the United States exhibit at the World Agricultural Fair in New Dehli, India. He began this special assignment in December and will return to the United States in March.

OMER W. HERRMANN, Agricultural Marketing Service, USDA, was appointed to the newly created post of Deputy Administrator for Marketing Research, effective October 9, with general supervision of four research divisions. He will also be responsible for AMS foreign marketing research contracts and grants under Sections 104a and 104k of Public Law 480.

PETER E. HILDEBRAND, who recently completed requirements for a Ph.D. at Michigan State University, has been appointed Assistant Professor of Agricultural Economics at Texas Agricultural and Mechanical College.

CLIFFORD HILDRETH has resigned as Head of the Department of Economics at Michigan State University, effective January 15, in order to become Editor of the *Journal of the American Statistical Association*. He continues as Professor of Economics. HARRY G. BRAINARD has been appointed Acting Head of the Department.

HOWARD C. HOGG, who finished his Master's Degree in agricultural economics at Oregon State College, recently accepted a position as Instructor in Economics at Southern Oregon College, Ashland. He began his official duties on October 26.

ROBERT HOOD has taken a position as Research Associate in the Department of Agricultural Economics at Cornell. He recently completed the requirements for his Ph.D. degree at Purdue.

SHERMAN JOHNSON, Chief Economist of the Agricultural Research Service, USDA, has returned from New Delhi, India, where he spent six weeks as

a consultant for the Ford Foundation to the Government of India in connection with setting up programs recommended by the Agricultural Production Team in their report, "India's Food Crisis and Steps to Meet It."

STANLEY S. JOHNSON, who recently finished work for his Ph.D. degree at Iowa State University, joined the staff of the Farm Economics Research Division, Agricultural Research Service, USDA, in September. He is stationed at Davis, California, where he will study the economics of adjustments on cotton farms in the San Joaquin Valley.

BRUCE F. JOHNSTON, Associate Economist in the Food Research Institute of Stanford University, attended a seminar on "African Population Studies" in Boston, Massachusetts, on November 9. The seminar was sponsored jointly by the African Research and Studies Program of Boston University and the Population Council.

NATHAN M. KOFFSKY, former Chief of the Farm Income Branch, Agricultural Marketing Service, USDA, was appointed to the newly created post of Deputy Administrator for Economics and Statistics, AMS, effective October 9.

J. B. KOHLMEYER, of the Agricultural Economics staff at Purdue University, has been granted half-time leave to become Director of the State School Reorganization Commission for Indiana.

WILLIAM G. LANGSTON, of the University of Maryland staff, has been appointed Secretary of The Governor's Special Egg Committee. The committee has submitted to the Governor a list of recommendations designed to strengthen the competitive position of the Maryland Egg Industry.

JERRY LAW, Assistant Professor of Agricultural Economics at Lousiana State University, finished the requirements for the Ph.D. at Michigan State University and will be awarded the degree in February.

C. W. LOOMER has been appointed Faculty Coordinator of Research in Recreation at the University of Wisconsin.

JOHN C. MACKEY, from the Austin, Texas, State Statistician's Office, has an extended detail to the Bureau of the Census, possibly for a year or longer, to assist in the 1959 Census operations at Parsons, Kansas. His detail began January 4.

CARL C. MALONE, Professor of Economics in the Department of Economics and Sociology at Iowa State University (Ames), returned December 1 from a six-week tour of India where he served as a consultant to the Ford Foundation in connection with India's food production program.

WILLIAM MANION has resigned from the Marketing Economics Research Division, Agricultural Marketing Service, USDA, and is now engaged in business in St. Paul, Minnesota.

WILLIAM T. MANLEY formerly on the staff of the Department of Agricultural Economics, University of Florida, has joined the Marketing Economics Research Division, Agricultural Marketing Service, USDA, and is stationed in Gainesville, Florida.

BRUCE MARION, formerly regional Extension Marketing Agent in New York State, has been appointed Extension Specialist in Food Merchandising at Ohio State University.

ART MAUCH has been designated as one of the team of agricultural policy

extension people visiting in seven countries of Asia during the late winter. They will visit Pakistan, India, Thailand, Indonesia, Australia, Philippines and Japan to study the P.L.480 program.

ROGER G. MAULDON has been appointed Research Associate in the Department of Economics and Sociology at Iowa State University.

ROBERT S. MCCAULEY, Field Crops Statistics Branch, Agricultural Estimates Division, Agricultural Marketing Service, USDA, is on extended detail to the Bureau of the Census for a period of 15 to 18 months beginning November 12. He will be stationed at Parsons, Kansas, and will assist in the 1959 Census operations.

GUY W. MILLER, Extension Professor Emeritus in Farm Management at Ohio State University is on a nine-month assignment with the World Bank in Pakistan.

SIDNEY E. MOGAN, who recently completed his M.S. program at Purdue University, has accepted a position as market research analyst with the Illinois Farm Supply Cooperative at Chicago.

W. H. M. MORRIS, of the Agricultural Economics staff at Purdue University, has returned from his leave for service as a member of the staff of the Max Planck Institute, Bad Kreuznach, West Germany.

RALPH NELSON, of South Dakota State College, was instructor in the Department of Agricultural Economics at the University of Minnesota during the fall quarter. He also completed his course work for the Ph.D. degree.

S. DANIEL NEUMARK, Economist in the Food Research Institute of Stanford University, attended a seminar on "African Population Studies" in Boston, Massachusetts, on November 9. The seminar was sponsored jointly by the African Research and Studies Program of Boston University and the Population Council. Professor Neumark presented a paper on "Population Trends in Relation to Agriculture."

TERRY NORMAN, of the Marketing Economics Research Division, Agricultural Marketing Service, USDA, is now stationed at Colorado State University. He formerly was at Denver.

KENNETH E. OGREN was appointed Director of the newly established Marketing Economics Research Division, Agricultural Marketing Service, USDA, effective October 9.

ROSS L. PACKARD, Special Statistics Branch, Agricultural Estimates Division, Agricultural Marketing Service, USDA, was selected in September as leader of the statistical training program for foreign nationals who seek instruction in this aspect of AMS work. In this assignment he has been appointed to the staff of American University as Lecturer in Mathematics and Statistics, and will conduct two graduate courses in Agricultural Estimating Methodology concurrently in the spring and fall semesters.

WALTER W. PAWSON, Farm Economics Research Division, Agricultural Research Service, USDA, has transferred from Pullman, Washington, to Tucson, Arizona, where he will work on a study of adjustments in beef production.

WILBUR T. PENTZER was appointed Director of the newly established Market Quality Research Division, Agricultural Marketing Service, USDA, effective October 9.

C. V. PLATH, Associate Professor of Agricultural Economics at Oregon State College, returned to his position on November 9 following a two-year

assignment in Bangkok, Thailand. Dr. Plath served as a special consultant on farm management and land economics in a program financed by the Council for Economic and Cultural Affairs. He will resume his duties in teaching and research in farm management and land economics at Oregon State College.

CARTER PRICE has received his M.S. at Texas Agricultural and Mechanical College and has joined the staff at Louisiana State University as an Instructor. He will work with research projects in grain marketing.

THOMAS S. RACKHAM, formerly on the staff of the Department of Economics and Sociology at Iowa State University, has been appointed an Assistant Professor in extension at the Ontario Agricultural College.

W. P. RANNEY has been promoted from Associate Agricultural Economist to Agricultural Economist at the University of Tennessee.

C. B. RATCHFORD moved from Assistant Director, North Carolina Extension Service, to Director, Missouri Extension Service, July 1.

BARBARA B. REAGAN, formerly head of income and expenditure studies, Household Economics Research Branch of the Institute of Home Economics, USDA, has been appointed Professor of Home Management and Family Economics Research at Texas Woman's University.

ROBERT O. ROGERS has transferred from the Farm Economics Research Division to Utilization Research and Development in the Agricultural Research Service, USDA. He will be a member of the recently established Product and Process Evaluation Staff.

EDWIN ROYER, formerly Assistant County Agent in New York, has been appointed Extension Specialist in Fruit and Vegetable Marketing at Ohio State University.

FREDERIC O. SARGENT, formerly Assistant Professor of Agricultural Economics at Texas Agricultural and Mechanical College, has been appointed an Associate Professor in land economics at the Ontario Agricultural College.

WOODROW SCHLEGEL transferred in October from the Marketing Economics Research Division, Agricultural Marketing Service, to the Foreign Agricultural Service, USDA.

RAYMOND C. SCOTT, Director, Division of Agricultural Economics Programs, Federal Extension Service, USDA, is FES representative on the study team going to Far Eastern countries in February under the expanded educational program in public affairs sponsored jointly by the Cooperative Extension Service and the Foreign Agricultural Service.

DONALD T. SEARLS, formerly in the State Statistician's Office at Raleigh, North Carolina, transferred to the Research Triangle Institute at Durham, North Carolina, on September 1.

JERRY A. SHARPLES joined the staff of the Farm Economics Research Division, Agricultural Research Service, USDA, in September, stationed at Columbus, Ohio.

KARL SHOEMAKER, Division of Agricultural Economics Programs, Federal Extension Service, USDA, will be FES representative on the study team that will go to South America in April under the expanded educational program in public affairs sponsored jointly by the Cooperative Extension Service and the Foreign Agricultural Service.

HAROLD SMITH, of the University of Maryland, recently completed an intensive study of the competitive position of major broiler areas. The work was

sponsored by the Delmarva Poultry Industry, Inc., and was a joint effort by the University of Maryland and the University of Delaware.

J. N. SMITH, Instructor in Agricultural Economics, University of Missouri, became Assistant Professor of Agriculture at Southwest Missouri State College, September 15.

ROBERT S. SMITH is Acting Project Leader in Agricultural Economics Extension at Cornell in the absence of C. A. Bratton.

CALVIN C. TAYLOR has transferred from the Farm Economics Research Division, Agricultural Research Service, USDA, to the U. S. Study Commission for the Southeast River Basins, Atlanta.

CLIFFORD C. TAYLOR has returned to the University of Maryland after spending one month in India as a consultant for an American firm which is interested in fertilizer production there.

ROBERT TAYLOR, formerly with the Farmers Home Administration in Arkansas, has joined the staff at Louisiana State University to work with research in sugar cane.

HARRY C. TRELOGAN, Agricultural Marketing Service, USDA, was appointed to the newly created post of Assistant Administrator for Marketing Research, effective October 9. He will aid the Deputy Administrator for Marketing Research in supervision of the four newly established research divisions that replace the former Marketing Research Division of which he had been Director.

LUTHER G. TWEETEN has been appointed Research Associate in the Department of Economics and Sociology at Iowa State University.

JOSEPH VON AH, who received the Ph.D. degree in Agricultural Economics from the University of Wisconsin in August, has accepted a position with the Swiss Ministry of Agriculture in Bern, Switzerland.

ROBERT M. WALSH was appointed Director of the newly established Market Development Research Division, Agricultural Marketing Service, USDA, effective October 9.

DARNELL M. WHITT, who has been ARS-SCS Liaison Officer since May 1956, and who was Secretary of the Joint Working Group for Studying the Facility Needs for Research in Soil and Water Conservation, has been made Director of the Farm and Ranch Planning Division, Soil Conservation Service, USDA.

FRED H. WIEGMANN has been named Chairman of the Department of Agricultural Economics at Louisiana State University. He succeeds Dr. M. D. Woodin, who has been promoted to Director of Resident Instruction for the College of Agriculture at Lousiana State University.

EDWARD WIGGINS moved from County Agent in Henry County to Extension Economist (Farm Management), University of Missouri, on January 1.

WILLARD F. WILLIAMS, formerly head of the Information and Statistics Section, Market Organization and Costs Branch, Agricultural Marketing Service, USDA, has accepted an appointment as Professor of Agricultural Economics at Oklahoma State University.

BERNIS WILLIAMSON has joined the staff at Louisiana State University as instructor to work on a canned sweet potato marketing study.

GARLAND WOOD has accepted a two-year assignment in Colombia under a grant to Michigan State University from the Kellogg Foundation. He will be working on the development of teaching and research activities in the two

agricultural colleges at Medellin and Palmira and is designated as Chief of Party. He will leave for Medellin early in January.

MALCOLM L. (MIKE) WOOD has resigned from Michigan State University to accept a position with the Chatham Food Stores in Detroit, Michigan.

OBITUARY

LYLE M. BENDER, Associate Director of Extension at the University of Nevada, died suddenly on November 18, following a heart attack. This was Dr. Bender's first year at Nevada. He went there from South Dakota, where he had been an Agricultural Economics Extension Specialist.

MINER M. JUSTIN, former State Statistician in Charge at West Lafayette, Indiana, died on September 9 of a heart attack. Mr. Justin had retired in June 1956.

ORGANIZATIONAL ANNOUNCEMENTS

The Committee on International Exchange of Persons of the Conference Board of Associated Research Councils would welcome inquiries from college and university faculty members who might be available for overseas lecturing assignments under either the Fulbright Program or the Smith-Mundt Act. Although the Fulbright competition for the 1960-61 academic year has officially closed, some openings, particularly in the sciences but also in other fields, may be unfilled under both European and Asian Programs. There will also be openings in Africa and in Latin America under the provisions of the Smith-Mundt Act.

A general interest in the Exchange Program may be expressed by submitting a biographical data sheet for the Register of Scholars, the Conference Board Committee's basic resource file for scholars in all fields for assignment abroad. The Committee has available publications describing the Register of Scholars, as well as detailed country programs.

Inquiries should be addressed to the Conference Board of Associated Research Councils, Committee on International Exchange of Persons, 2101 Constitution Avenue, N. W., Washington 25, D.C.

A symposium on Capital and Credit Problems in a Changing Agriculture is being held at Knoxville, Tennessee, March 29-April 1. This symposium is being sponsored jointly by the Tennessee Valley Authority, the Farm Foundation, and the Center for Agricultural and Economic Adjustment, Iowa State University. The sponsoring organizations are being actively assisted by the U. S. Department of Agriculture.

The aims of the symposium are to examine the national and regional capital and credit structure for agriculture (a) as it now exists, (b) as it has performed in the past, and (c) as it might be changed to encourage agricultural adjustments, especially during the next decade. The proposed symposium is directed toward agricultural workers who are concerned with research, extension educational activities, and policy on these problems in the land-grant colleges, public agencies, and credit agencies. It is hoped that this conference will provide a

more sound analytical framework for handling capital and credit problems to accommodate the desired adjustments in agriculture.

For further information, please address inquiries to E. L. Baum, Chief, Agricultural Economics Branch, Tennessee Valley Authority, Knoxville, Tennessee.

The Cooperative Extension Service in cooperation with the Foreign Agricultural Service, USDA, in order to undertake an expanded educational program in public affairs, has organized teams of State extension economists for a study program abroad. The objective is to gain better understanding of the agricultural market development problems abroad and of foreign agricultural trade and trade policies, so as to facilitate the development of a better educational program which, in turn, will result in improved trade relations, market expansion, and more effective trade and economic policy.

Agricultural Marketing Service, USDA, announced the establishment of four new research divisions, effective October 9, replacing the four branches of the former Marketing Research Division: a Marketing Economics Research Division, replacing the Market Organization and Costs Branch; a Market Development Research Division, replacing the Market Development Branch; a Market Quality Research Division, replacing the Biological Sciences Branch; and a Transportation and Facilities Research Division, replacing the Transportation and Facilities Branch. These divisions will be under the general supervision of a Deputy Administrator and an Assistant Administrator for Marketing Research.

A post of Deputy Administrator for Economics and Statistics was simultaneously announced, to have general responsibility for the work of the Agricultural Economics and Agricultural Estimates Divisions, the Statistical Standards Division, and the Outlook and Situation Board.

THE AMERICAN FARM ECONOMIC ASSOCIATION AWARDS FOR RESEARCH IN AGRICULTURAL ECONOMICS, 1960

To recognize and encourage meritorius research in agricultural economics, seven awards of $250 each will be presented in 1960 by the American Farm Economic Association. In addition, three awards of $100 each will be presented for master's degree theses.

Selection for the awards will be made from published research, Ph.D. theses, and M.S. theses submitted for consideration in accordance with the procedures outlined below. No one may receive an award in the same category more than once every three years.

Awards for Published Research

1. Three $250 awards, each in a different field of agricultural economics will be made for publications including bulletins, articles, pamphlets and monographs (textbooks are ineligible) classified in the following categories:

(a) Farm management and production economics
(b) Agricultural marketing
(c) Agricultural prices
(d) Agricultural finance
(e) Land and water economics and conservation
(f) Theory and Methodology
(g) Agricultural Policy
(h) General agricultural economics

2. Persons submitting items should indicate the field in which they believe the reports should be classified.

3. Selections will be made from published research bearing the publication date of 1959.

4. Eligible recipients must be less than 41 years of age at the time of publication.

5. Members of the Awards Subcommittee for Published Research will not be eligible to submit papers of their own.

6. Each published report may receive only one award presented by the American Farm Economic Association in 1960. An entry may, however, be entered in more than one of the following categories: (a) Best article appearing in the *Journal of Farm Economics;* (b) Published research; and (c) Ph.D. thesis.

7. Nine copies are requested of each publication submitted for consideration. Fewer copies will be accepted in such cases as articles appearing in national journals available to the judges. In no event should less than three copies be sent.

8. The Awards Subcommittee for Published Research will consist of nine persons, in addition to the Chairman, representing the various designated fields. The members of the Subcommittee, all of whom will serve as judges, are:

Ernest T. Baughman, Federal Reserve Bank of Chicago
Harold F. Breimyer, Council of Economic Advisors
George K. Brinegar, University of Connecticut
Marion Clawson, Resources for the Future, Inc.

D. B. DeLoach, University of California
Harold R. Jensen, University of Minnesota
Donald R. Kaldor, Iowa State University
Raymond J. Penn, University of Wisconsin
M. D. Woodin, Louisiana State University

9. Publications should be sent directly to the Chairman of this Subcommittee, J. Carroll Bottum, Department of Agricultural Economics, Purdue University, Lafayette, Indiana, *on or before March 15, 1960.*

AWARDS FOR PH.D. THESES

1. Three $250 awards will be made for theses prepared by candidates for the Ph.D. degree in any department of Economics or Agricultural Economics.

2. An entry must be submitted by the head of the department to which the thesis was presented in partial fulfillment of requirements for a degree. A department may submit one thesis for each eight Ph.D. theses or fraction thereof presented to a graduate school faculty in 1959.

3. Selections will be made from those presented to a graduate school faculty during the calendar year 1959.

4. A published thesis may be entered in both the published research and thesis classes but will be eligible for only one award. Although a published thesis is acceptable, a copy of the thesis as submitted to the graduate faculty should be sent whenever possible.

5. Only one copy of an unpublished thesis will need to be sent to the Committee Chairman for consideration; however, if 2 or 3 are available it will expedite the judging. All copies will be returned after they have been read by the judges.

6. The Awards Subcommittee for Ph.D. Theses will consist of three persons, in addition to the Chairman. These three persons, all of whom will serve as judges, are:

Norman Collins, University of California
R. W. Rudd, University of Kentucky
S. D. Staniforth, University of Wisconsin

7. Theses should be sent directly to the Chairman of this Subcommittee, George G. Judge, Department of Agricultural Economics, University of Illinois, Urbana, Illinois, *on or before March 15, 1960.*

AWARD FOR BEST ARTICLE IN JOURNAL OF FARM ECONOMICS

As has been the practice for a number of years, the Editors and Editorial Council of the *Journal of Farm Economics* will again choose the most outstanding article published in the *Journal* during the preceding calendar year (in this instance 1959). The amount of this award is $250.

AWARDS FOR M.S. THESES

1. Three $100 awards will be made for theses prepared by candidates for the M.S. degree in any department engaged in training agricultural economists at the master's degree level.

2. An entry must be submitted by the head of the department to which the thesis was submitted in partial fulfillment of requirements for a degree. No department may submit more than one thesis for consideration.

3. Selections will be made from those presented to a graduate school faculty during the calendar year 1959.

4. Only one standard typewritten copy as submitted to the graduate faculty need be sent to the Committee Chairman for consideration, but if two copies can be sent, it will be appreciated by the Committee. All copies will be returned after the Committee has completed its work.

5. The Awards Subcommittee for M.S. Theses will consist of four persons in addition to the Chairman. These four persons, all of whom will serve as judges, are:

James S. Gilson, University of Manitoba
Harlow W. Halvorson, University of Wisconsin
William D. Toussaint, University of North Carolina
John Sjo, Kansas State University

6. Theses should be sent directly to Fred H. Wiegmann, Chairman of the Subcommittee, Department of Agricultural Economics, Louisiana State University, University Station, Baton Rouge, Louisiana, *on or before March 15, 1960.*

Announcements of the 1960 awards will be made at the 1960 annual meeting of the American Farm Economic Association. Names of the recipients of the 1959 awards appear in the Proceedings Issue of the *Journal of Farm Economics.*

These awards are financed in part from funds donated by persons and firms interested in advancing research and scholarship in Agricultural Economics. The funds and programs are administered by the American Farm Economic Association. General inquiries, and requests for additional copies of this announcement, should be directed to the Chairman of the Awards Committee, Leonard F. Miller, Department of Agricultural Economics, Oklahoma State University, Stillwater, Oklahoma.

ANNOUNCEMENT OF SECTIONAL MEETINGS FOR CONTRIBUTED PAPERS

American Farm Economic Association Annual Meeting
Iowa State University, August 10-13, 1960

Sectional meetings for contributed papers will be held during the Annual Meeting—two on Thursday, August 11, and two on Friday, August 12. Contributed papers in four subject matter areas are solicited. These areas and their chairmen are:

1. *Consumption, Marketing and Distribution*
—Stanley K. Seaver, University of Connecticut, Storrs, Connecticut
2. *Farm Management and Production Economics*
—James S. Plaxico, Oklahoma State University, Stillwater, Oklahoma
3. *Land Economics, Farm Finance and Institutional Economics*
—Maurice M. Kelso, University of Arizona, Tucson, Arizona
4. *Teaching Agricultural Economics*
—Lawrence A. Bradford, University of Kentucky, Lexington, Kentucky

Rules for Submitting Contributed Papers

1. The maximum length of any contributed paper shall be seven double-spaced, typewritten pages.

2. The title of the contributed paper to be submitted shall be sent to the chairman of the area by May 15, 1960.

3. A draft of the contributed paper shall be submitted to the chairman of the area by June 20, 1960.

4. The maximum number of contributed papers to be presented at any sectional meeting shall be five. In case more than five papers are submitted it shall be the responsibility of the chairman in consultation with several of his departmental colleagues to select the five papers for presentation at the Annual Meeting.

5. At the time of the Annual Meeting a two-page, double-spaced, typewritten abstract of the paper is to be turned over to the chairman for inclusion in the Proceedings Issue.

6. It is recommended that 50 copies of the contributed papers be brought to the Annual Meeting by the author for distribution to those present.

Specific questions concerning papers to be submitted should be directed to the chairman of the subject-matter area concerned. General questions concerning this aspect of the 1960 Annual Meeting should be directed to Aubrey J. Brown, General Chairman of the Sectional Meetings for Contributed Papers, University of Kentucky, Lexington, Kentucky.